Utility divestitures in Germany

A case study of corporate financial strategies and energy transition risk

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Abstract

Germany is in the midst of a radical transformation of its power sector, which in 2016 led two of its main electric utilities, EON and RWE, to undertake dramatic restructurings. EON spun off its fossil fuel and trading segments, while RWE carved out its renewable energy, retail and grid business.

The paper examines the drivers of these divestitures. Building on corporate finance literature, the paper uses a mix of comparative descriptive statistics, interviews and event studies to test four groups of hypotheses. The evidence rejects drivers related to operations and management, biased investment and investor preferences and instead points to financing-related drivers. Among the financing-related drivers, debt overhang and risk contamination seemed to have played the main role. Utilities restructured to save their healthy assets (renewables and grid infrastructure) from losses at their conventional power generation business (fossil fuel and nuclear plants).

Already weakened from record losses in their fossil fuel powered generation fleet due to low electricity prices, after 2011 the nuclear exit emerged as an additional challenge to the utilities. Investors doubted the adequacy of utilities provisions for decommissioning nuclear power plants and storing toxic waste, and feared major cost increases for which the utilities would be unlimitedly liable.

The paper uses existing research on divestitures in an empirical case that has implications for the evolution of European power markets. The results suggest that exiting conventional technologies as part of the transition to a more renewable energy mix might cause substantial costs. If these are not clarified and allocated ex ante, policy makers might find themselves forced to either burden tax payers or endanger utilities that are of systemic relevance to the energy sector.

Key words— Electric utilities; event study; risk; energy transition; nuclear power; renewable energy.

Contents

1 Introduction

Germany has set about a radical transformation of its electricity sector. After having supported fossil fuel- and nuclear-based power production since the 1950s, the government embarked on an increasingly green agenda in the 1990s: starting in 1991, renewable power plants received guaranteed feed-in tariffs leading to a share of more than a third of electricity produced in 2017. The exit from nuclear power was negotiated and amended several times between 2000 and 2011, resulting in a step-wise exit plan ending nuclear electricity production by 2022. Power generation from nuclear plants decreased from 28% in 1990 to 12% in 2017. Current governmental efforts include a strategy to phase out coal-based electricity generation in the 2030s.

In recent years, the two biggest German electric utilities, EON and RWE, together responsible for 18%[1] of German generation capacity, had the most difficult times of their history. From 2010 their net income declined and by 2015 EON and RWE had booked the biggest net losses in their history: EUR -2.4 billion in 2013 (RWE) and -6.4 billion in 2015 (EON). From 2011 to 2015 each wrote off more than 13% of their book asset value and lost between 70% (EON) and 80% (RWE) of their market capitalisation.

EON and RWE, until then integrated firms spanning the whole energy value chain, responded with two of the most dramatic restructuring moves in recent German corporate history and in the history of privately-run European utilities as a whole. In late 2014, the biggest utility EON announced that it would carve out a new subsidiary consisting of its fossil fuel, nuclear, hydro and trading segments. The original strategy was altered by the German government, which insisted that the parent firm remains liable for all future liabilities connected to nuclear energy, even if the nuclear plants are spun off. EON decided to keep the nuclear segment. It carved out fossil fuel- and hydro-based generation and the trading segment, the equivalent of 56% of EON's 2015 book asset value, into the new firm Uniper and spun off 53.35% of Uniper to its existing shareholders in September 2016. In 2018, EON sold their remaining stake in Uniper to their competitor Fortum.

For RWE, being the second mover, it was already clear that policy makers would not allow nuclear liabilities being spun off. As a result, RWE embarked on the opposite route. In December 2015 it announced that it would carve out renewable energies, retail and grid infrastructure, but keep a majority stake in the new firm Innogy. In October 2016, the IPO of Innogy, worth 73% of RWE's 2015 book asset value, the biggest flotation in Germany since 2000 and the second largest worldwide that year, raised 4.6 billion Euros. By the end of 2016, Innogy had a market capitalisation of 18.3 billion Euros - making it the biggest German energy utility (RWE 2016, Innogy 2016). RWE, on the other hand, its own operations solely based on nuclear, old hydro, fossils and trading, depended on Innogy for 75% of their EBITDA. (Innogy 2017, RWE 2017)

Why did EON and RWE divest and why did they differ in their approach? While the firms themselves argued that the restructurings would bring about a large array of benefits, encompassing almost all possible advantages ever discussed in the context of divestitures, this paper critically assesses different hypotheses from the corporate finance literature and establishes the main reasons responsible for the decisions. Methodologically, a mix of qualitative research, interviews, descriptive statistics and event studies is used. The results of the different methods converge in rejecting drivers related to operations and management, biased investment and investor preferences and in confirming debt overhang and risk contamination as the main drivers.

Already weakened from record losses in their fossil fuel powered generation fleet due to low electricity prices, after 2011 the nuclear exit emerged as an additional challenge to the utilities. Investors doubted the adequacy of utilities provisions for decommissioning nuclear power plants and storing toxic waste, and feared major cost increases for which the utilities would be unlimitedly liable. Utilities restructured to avoid further risk contamination of their healthy assets (renewables and grid infrastructure) by the conventional power generation business (fossil fuel and nuclear plants).

The paper uses existing research on divestitures in an empirical case that has implications for the evolution of European power markets. The results suggest that exiting conventional technologies as part of the transition to a more renewable energy mix might cause substantial costs. If these are not clarified and allocated ex ante, policy

[1] Number calculated for 2014 from different sources (Bundesnetzagentur 2012, Bontrup and Marquardt 2015, Bloomberg 2018).

makers might find themselves forced to either burden tax payers or endanger utilities that are of systemic relevance to the energy sector.
The paper is structured as follows. Section 2 lays out the goal and contribution of this paper. Section 3 reviews the corporate finance literature and distils its main hypotheses and their relation to each other. Section 4 gives an overview of the methodology used. Section 5 summarizes the main hypotheses and results. Section 6 to 9 are each dedicated to testing one group of divestiture drivers: drivers related to operations and management, investing, financing and investor preferences. Section 10 concludes and suggests policy implications as well as ideas for further research.

2 Goal and contribution

The goal of this paper is to investigate why EON and RWE divested in 2016 and why their approach was at the same time very similar - they separated their business segments in exactly the same way - yet different - EON intended to keep renewables and grid infrastructure and spun off the rest, while RWE kept the other part: conventional generation and trading.
Why do we care to know what was driving the two utility divestitures in Germany and changes in the utility sector more generally? World wide, electricity markets are transitioning from a fossil fuel- and nuclear-based power supply towards more renewables. As in the case of Germany, the transition has major consequences on incumbent utilities and thereby on the existing electricity system as a whole. This is all the more important, as electricity related services are generally regarded as basic goods that should be reliably available to all. Affordable and reliable access to electricity is also a fundamental factor for private investment and thereby a country's economic wealth. Moreover, electricity markets have strong monopoly tendencies and state policies play an important role. For these reasons, researchers and policy makers should have a vital interest in understanding the problems and strategies of utilities in order to apply lessons learned in Germany to other countries on a similar path away from nuclear and fossils to more renewable electricity sources.
This paper is part of the energy finance and policy literature dedicated to utilities. A growing number of articles analyses the impact of the energy transition on utilities. For example, Kawashima and Takeda (2012) analysed the effect of the Fukushima nuclear accident on utility stock prices; Koch and Bassen (2013) attempted to value the the carbon exposure of European utilities and Frei et al (2018) investigated changes in utilities' business portfolios world wide.
A number of studies (e.g. Annex and Typoltova 2018, Bontrup and Marquardt 2015) and academic articles (e.g. Helms et al 2014; Kungl and Geels 2018; Sen and Schickfus 2017; Ossenbrink et al forthcoming; Weber 2017) have specifically analysed German utilities. The drivers of the EON-Uniper and RWE-Innogy divestitures, however, the two most radical restructurings by diversified electric utilities to date, have not been analysed in the academic literature so far. Bebb, Comello and Reichelstein (2017) provide a detailed and interesting account of the Innogy carve-out, but it being a teaching case, they do not pin down the divestiture's drivers.
The selection of the German utility divestitures for a case study is justified for at least three reasons. First, it is a fairly typical case in that Germany's electricity system relied mainly on coal, natural gas and nuclear and policy makers' had started pushing a transition to more renewables, just like in many European countries today.
The German power sector is thus typical in its direction of change, yet, second, also extreme in its progressiveness and speed, as support policies for renewables were among the most generous worldwide and the nuclear exit one of the most ambitious ones. We should therefore observe typical effects of an energy transition, but more pronounced than we might in cases with moderate policies.
Third, EON and RWE are very similar utilities regarding their main segments, generation portfolios and business models. Being mainly active in Germany (see annex), they were exposed to the same market changes. One factor was different, though: for RWE it was clear that policy makers would not allow nuclear liabilities being spun off. As a result, RWE's restructuring was different from EON in one aspect, that is in what part of the company was carved

out.
The cases of EON and RWE therefore combine three useful features described in the literature on case selection that make them particularly suitable to test: they are at the same time "typical", "extreme" and "most similar" as Seawright and Gerring (2008) would put it.
The paper's analysis thus contributes to the energy finance and policy literature. Moreover, it also offers a modest contribution to the corporate finance divestiture field: for the first time, it distinguishes between outcomes and drivers of divestitures, it systematises different divestiture drivers and corresponding testable indicators and thereby contributes to a more coherent framework for analysing divestitures.[2]

3 The divestiture literature

The goal of the literature review is to distil hypotheses that explain corporate divestitures. These hypotheses are subsequently used to examine the possible drivers of EON's and RWE's divestitures.
Three main types of divestitures are distinguished in the literature. The asset sale is the sale of a subsidiary or other assets directly from one firm - the parent firm - to another firm. The spin-off is a pro-rata distribution of shares in a subsidiary to the existing shareholders of the parent firm. The equity carve-out is an IPO (initial public offering) of a subsidiary, i.e. the offering of shares in a subsidiary to the investment public (Weston et al 2004). EON used a spin-off whereas RWE did an equity carve-out.

3.1 Divestiture outcomes

3.1.1 Corporate focus

Starting in 1995, researchers found a trend in divestitures towards increased firm focus and a correlation of this increased focus with positive share price effects and better operating performance following the divestitures (Comment and Jarrell 1995, John and Ofek 1995). It became common practice in the literature to regard increased corporate focus as a possible driver of divestitures. In contrary, this paper regards it as an outcome as the underlying reason making a lower number of firm segments more attractive remains unclear. This outcome is used as an indicator pointing to operations and management related drivers.

3.1.2 Access to funds

Access to funding is another explanation brought forward in the divestiture literature. This paper regards access to funding as an outcome as well, rather than a driver, for a driver would need to explain why a firm incurs the costs of restructuring as opposed to simply raising more debt or equity on the capital markets. It would need to explain why money raised through the divestiture directly (asset sale or equity carve-out) or later as capital taken up by the new subsidiary or the rump parent company (spin-off or equity carve-out) is cheaper than capital raised by the original parent firm.
The access-to-funds topic has been distinguished in two ways in the literature. The first possibility is that the divestiture decreases the firm's higher-than-average debt either by using the proceeds directly to retire debt and thereby reducing financial distress (Brown, James and Mooradian 1994; Lang, Poulsen and Stulz 1995) or by transferring debt to their subsidiary (Desai and Jain 1999). This outcome would hint at debt overhang being a main driver.
The second possibility is that the goal is to raise funds for growth in the subsidiary (Schipper and Smith 1986; Daley, Mehrotra and Sivakumar 1997; Vijh 2002).[3] This outcome could hint at a number of drivers, which would need to explain why growth opportunities cannot be funded in the integrated firm, e.g. debt overhang, agency conflicts related to investing or risk contamination (see also table 1).

[2] Similar to what Steffen (2018) does for project finance.
[3] This holds only for equity carve-outs, where funds are raised immediately, and for spin-offs, where funds can be raised later in the separate firm, but not for asset sales, where the subsidiary does not become a separate entity.

3.2 Divestiture drivers

Drivers are divided into four groups: operational and management aspects, investing, financing and investor preferences.

3.2.1 Drivers related to operations and management

The first group of drivers refers to the relationship of the firm's operations to each other and to the managers. Authors generally use poor performance pre- and better performance post-divestiture to argue for operational and management related drivers.

Inefficient diversification. The inefficient diversification argument suggests that managers previously diversified inefficiently, driven by agency problems like empire building (Jensen 1986, 1988), hubris (Roll 1986), managerial entrenchment (Shleifer and Vishny 1989) or managerial discretion (Stulz 1990, see also in investing section).

Change in synergies. Similarly, a change in synergies between business segments might also lead to poor performance and drive firms to divest (Hanson and Song 2003). Reasons for changes in synergies might be changes in regulations or technical innovations (Shleifer and Vishny 1990; Kaplan and Weisbach 1992).

Lack of fit with owner or better fit with buyer. Another driver of divestitures might be a better fit with the buyer's skill set (John and Ofek 1995; Daley, Mehrotra and Sivakumar 1997).

Management focus. Even if the skill sets of managers in subsidiary and rump parent firm are not so different, one could argue that simply the reduction of diversity of the assets under management by one team increases the efficiency of the managers (Berger and Ofek 1995; Desai and Jain 1999).

3.2.2 Drivers related to investing

The second group of drivers is related to suboptimal investment decisions by the management in the integrated pre-divestiture firm, be it at headquarters or in the divisions. Suboptimal investments are caused by some type of agency conflict between managers and shareholders. The result is a 'pecking order' in the sense of Myers (1984), where proceeds from a divestiture or capital raised in the post-divestiture firms are cheaper than new equity or debt in the integrated firm. Lang, Poulsen and Stulz (1995) first referred to this in the context of divestitures.

Asset substitution. This driver refers to the danger of managers being pushed into high risk projects by shareholders at the expense of debt holders, as shareholders have unlimited upside but limited downside risk. The mechanism was first discussed by Jensen and Meckling (1976). Lang, Poulsen and Stulz (1995) and Officer (2007) mention it as a potential driver for divestitures, albeit without going into detail.

Managerial discretion. This is another agency problem causing less than optimal investments. The argument was first developed by Jensen (1986). Due to personal benefits linked to investments, managers always claim that cash flow is too low to fund all positive NPV projects. Their claim is therefore not credible when cash flow is truly low. The result is a situation of under-investment when cash flow is low and over-investment when it is high, as capital markets price in the agency conflict (Stulz 1990). Divestiture might therefore be a cheaper way to raise funds directly than on the capital markets.

Rent-seeking by divisions. Another explanation for suboptimal investment in the integrated firm is a failure to optimally allocate capital to different divisions. Meyer, Milgrom, and Roberts (1992), Wulf (1997) and Scharfstein and Stein (2000) theoretically model how rent-seeking by the divisions can induce corporate headquarters to allocate excessive capital to divisions with poor investment opportunities. Empirically, Lamont (1997), Shin and Stulz

(1998), Scharfstein (1998), Rajan et al. (2000), among others, have shown that conglomerate divisions might receive cross-subsidies, that is more funds than is justified by their own cash flows or by their growth opportunities. In the empirical divestiture literature, Dittmar and Shivdasani (2001) find that after asset sales parents' investment allocation improves. Gertner, Power and Scharfstein (2002) find that spun-off subsidiaries optimize their capital allocation.

Failure of capital allocation method. A fairly recent stream in the literature relates to the failure of companies to adequately reflect the risk-return profile of different projects in their capital allocation method. Krüger et al (2015) argue that, controlling for growth opportunities, companies are inclined to invest less in their low-risk divisions because they use one single cost of capital to appraise projects across segments. Helms, Salm and Wüstenhagen (2014) have applied the same argument to utilities' investment behaviour.

3.2.3 Drivers related to financing.

The last group of drivers analyses the effect of financing decisions in an integrated compared to a separated firm. While most drivers assume an effect of financing on investment incentives, appropriate gearing and the risk contamination effect can be explained through purely financial effects keeping investment constant.

Debt overhang. Debt overhang describes a situation where a positive NPV project cannot be funded by either debt or equity, because the project returns would partly benefit existing creditors (Myers 1977). This might explain why asset sales can be attractive: the proceeds might be cheaper than money from the capital markets. And the firm could use the funds to retire debt, thereby alleviating the debt overhang. The problem is mentioned by Lang, Poulsen and Stulz (1995) and Hanson and Song (2003) in the divestiture context and high leverage is generally used as an indicator for poor financing options of divesting firms (see also divestiture outcomes). For spin-offs, Desai and Jain (1999) hypothesise that the firm could get rid of some debt by transferring it to the new subsidiary.

Appropriate gearing. Some authors argue that the debt overhang problem can be less severe for separate as opposed to integrated firms. For example, Myers (1977) observes that depending on the joint cash flows and existing debt either separate or joint financing can lead to better investment incentives. John (1993) models spin-offs and shows that when divisional cash flows are positively correlated, spin-offs can lead to value increases: the "intuition is that for sufficiently high debt levels on the parent firm, there is a lock-up effect such that the technologies are either exercised together or neither is exercised. The flexibility afforded by optimally allocating the debt between components improves investment incentives." (John 1993, p. 139)
Leland (2007) relies on purely financial effects to develop the appropriate gearing hypothesis, i.e. investment incentives and investment stay constant. He assumes an optimal debt level in the trade-off theory sense: the benefit of a debt-related tax shield is balanced against the increase in bankruptcy cost with higher debt levels. Depending on whether a divestiture increases or decreases the overall tax shield in the two henceforth separate firms taken together, there is thus a positive or negative effect from appropriate gearing after divestiture (Leland 2007).

Risk contamination. The risk contamination argument constitutes the other half of Leland's model and it is an unambiguously positive financial effect of separation. It is essentially the downside of the co-insurance effect: divisions can co-insure each other, but they can also contaminate each other. Specifically, if divisions' cash flows can be negative, one division can eat into another one's cash flows or even assets (Scott 1977; Sarig 1985). In a separated structure, one division's losses are limited by the same division's assets with no effects on other divisions. Leland (2007) calls this the 'limited liability (LL) effect' of separation. His model predicts that the benefits of separation increase in segments' cash flows correlation and with high or very different volatilities or default costs. Banal-Estanol, Ottaviani and Winton (2013) extend the analysis to show that also without the 'appropriate gearing' aspect, i.e. when holding total debt constant, the net of LL and co-insurance effect can justify separation.

Asymmetric information. The asymmetric information hypothesis goes back to a paper by Myers and Majluf (1984) that inspired the development of the pecking order theory of capital structure. Managers know the true value of the firm's assets and growth opportunities whereas outside investors can only guess. Acting in the interest of existing shareholders, managers cannot issue new stock for all positive NPV projects because equity issues signal the firm being overvalued by the market. They thus prefer internal funds to debt and debt to equity. Nanda (1991) extends the model and explains why equity carve-outs on average have a positive effect on the parent's share price, contrary to seasoned equity offerings. It is, however, not applicable to EON or RWE.[4]
Another mechanism related to asymmetric information might be that asymmetric information is reduced simply by going public or it is less relevant for the subsidiary in the first place (Schipper and Smith 1986). Several researchers have examined the reduction in information asymmetry by looking at analysts' forecast dispersion or error or an increase in coverage by analysts post-divestiture (Best, Best and Agapos 1998; Krishnaswami and Subramaniam 1999; Gilson et al 2001; Chen and Guo 2005).

3.2.4 Drivers related to investor preferences

The last driver rests on the assumption that investors have heterogeneous preferences and that spin-offs and equity carve-outs facilitate the trading in different stocks than pre-divestiture. Value creation might thus stem from relaxing a trading constraint that existed previously. Vijh (1994) finds increased trading volume and abnormal positive stock returns on the day that the subsidiary starts trading separately. This is somewhat surprising since the split-off had been announced before. Were value gains related to the parent firm only, one would expect share price improvements taking place on the announcement day and the ex date not having any significant effect. Excluding measurement errors and arbitrage, Vijh, similar to a later paper by Chemmanur and He (2017), concludes that heterogeneous preferences must be driving the share price gains on the ex date.

Shunning of sin stocks. One way to explain specific investor preferences in the context of electric utilities would be the shunning of sin stocks. Hong and Kacperczyk (2009) provide evidence that ethical norms restrict holding of firms involved in alcohol, tobacco and gaming by certain institutional investors, leading these stocks to trade at a premium.

Search for yield. The low interest rate environment of the last years is another possible driver of investors' demand for certain stocks and corporate bonds as an alternative to zero or negative interest sovereign bonds. Renewable energy assets, for example, have been discussed in the industry as assets with potentially "strong long-term growth potential with low correlation to other asset classes, while also providing stable cash flows and meaningful dividend yields" (Allianz 2017, p. 1; Ernst and Young 2014). This could explain why there might be great demand for the stock of a new EON and RWE's carved-out Innogy as they are geared towards renewables and regulated network infrastructure.

4 Methodology

The paper is mainly based on a combination of four methods. While comparative descriptive statistics, interviews and an analysis of the gray literature are used to test all hypotheses, the event studies are only used to investigate two hypotheses that were often referred to in the interviews: risk contamination and investor preferences.
As described in more detail in section 5.2, the results of the different methods converge in identifying debt overhang and risk contamination as the main drivers. Investor preferences was often argued for as a driver by interviewees, but the analysis could not distinguish the argument sufficiently from the risk contamination driver.

[4] Nanda's model is only applicable to divestitures with immediate funds being raised, thus not to EON. It hinges on the assumption that the subsidiary is smaller than the parent so that the positive share price effect of the parent's being undervalued dominates. Innogy, however, is more than 40% larger in terms of book asset value and market cap than its parent RWE ex Innogy.

1. **Comparative descriptive statistics**: Relying on the Stoxx 600 Europe Utilities index, two control groups of other listed European utilities were established - one containing all other 24 utilities on the index, the other one only those nine that were similar in products, markets and shareholders to EON and RWE. The method for obtaining the control groups is described in the annex. Indicators that were distilled from the divestiture literature are then plotted for EON, RWE and compared to the control groups. Given that no other European utility restructured in a similarly important way, stark differences between EON and RWE as opposed to the control groups might be taken as evidence for certain divestiture drivers. On the other hand, if EON and RWE were very similar to their control groups in certain indicators, this might be evidence against these drivers.[5]

2. **Interviews**: in the course of 2018, 20 interviews were conducted to triangulate the other methods. The interviewees were 10 people who worked at EON or RWE in 2016, of which two and three were from management, and three and two from staff at EON and RWE respectively. Ten were experts, of which three equity analysts, three financial news journalists, two from management at two other European utilities and two academics. The clear focus of the responses on a couple of drivers turned out to be in line with the rest of the analysis.

   All interviews were done in a semi-structured way and started from the question: "What do you think were the main drivers responsible for the splits of EON and RWE in 2016?" so as to not bias the responses initially. In the course of the interview, all possible drivers identified were then offered as potential alternative explanations.

3. **Analysis of gray literature**: EON and RWE annual reports (2005-2017), investor presentations, and more than 280 newspaper articles have been analysed in order to enrich and triangulate the results of the other methods.

4. **Share price event study**: Using regression analyses, the effect of different events on EON's and RWE's share price and stocks traded is examined. The tests are used to examine whether certain types of new information were perceived as a risk for the utilities' future growth options in line with the risk contamination hypothesis developed earlier and whether the ex dates had an effect on trading indicating evidence for heterogeneous investor preferences.

5 Hypotheses and summary of results

5.1 Hypotheses and indicators

Table 1 lists the possible drivers with empirical indicators identified from the literature. The drivers related to operating and management are all summarized into one column, as well as the drivers related to investing and to investor preferences, whereas the financial drivers are listed separately because their distinction will be important later on. The cells are only filled if the corresponding hypothesis predicts the indicator to be confirmed. Indicators that are confirmed are marked with yes and rejected with no. The last line summarizes the paper's overall conclusions by stating whether sufficient evidence could be gathered for each driver. Only if all of the relevant indicators are confirmed, evidence is deemed sufficient to confirm a driver. Drivers are rejected if at least one indicator is marked with no. Only debt overhang (III.1.) and risk contamination (III.4.) are confirmed; all other drivers are rejected.

5.2 Summary of interview results and overall analysis

Table 2 shows the number of interview partners supporting each hypothesis. For anonymity reasons the results cannot be distinguished any further, but there were no trends evident in responses from different sub-groups.

[5] Vattenfall and EnBW, even though they own the third and fourth biggest generation portfolio in Germany, are not part of the control group. They are dominated by public shareholders holding more than 95% and are not part of the Stoxx index.

Indicator/**Driver**	**I.Operations and management**	**II.Investing**	**III.1.Financing: debt overhang**	**III.2.Financing: appropriate gearing**	**III.3.Financing: asymmetric information**	**III.4.Financing: risk contamination**	**IV.Investor preferences**
Low performance pre-, better post-divestiture	Yes	Yes	Yes			Yes	
Increase in focus	Yes						
Changes in synergies pre-divestiture	No						
New managers with different skill sets	No						
Funds raised for growth		Yes	Yes			Yes	
Funds raised for retirement of debt			Yes				
High overall capex/assets		No					
High correlation capex with cash flows		No					
Low capex in renewables vs. conventional		No					
One cost of capital used for all segments		No					
High leverage			Only if incl. nuclear provisions				
Higher tax shield post-divestiture				No			
Improved earning estimates post-divestiture					Only at RWE's Innogy		
Different valuations parent vs. subsidiary						Yes	
Big past and risk of future losses in one part of firm						Yes	
Share price effect on ex date							Only on RWE-Innogy ex date
Investor preference for renewables and grids over conventional generation							Possibly but unclear if loss avoidance
Divestments due to political commitments							No
Driver confirmed?	**No**	**No**	**Yes**	**No**	**No**	**Yes**	**No**

Table 1: Hypotheses with main indicators tested in this paper. Indicators that are confirmed are marked with yes, undecided with unclear and rejected with no. Cells are empty for indicators not relevant for the respective hypotheses. The last line summarizes the overall result for each driver tested.

	Experts	EON	RWE	Total
Total number of interviewees	10	5	5	20
Drivers related to operations and management	3-2	4-1	1-1	8-4
Drivers related to investing	1	1		2
Drivers related to financing: debt overhang	2			2
Drivers related to financing: appropriate gearing	1	1		2
Drivers related to financing: asymmetric information	1			1
Drivers related to financing: risk contamination	8	4	3	15
Drivers related to investor preferences	7	5	4	16

Table 2: Number of interviewees supporting each driver.

Interview results strongly concentrate on two drivers: risk contamination (III.4.) and investor preferences (IV., total support of 15 and 16). The rest of the paper succinctly analyses each driver. Most detail is dedicated to risk contamination, as it is the most complex and the main driver argued for in this case study.
Sections 6-9, which follow, will in turn examine each hypothesis. Each analysis usually comprises comparative descriptive statistics, data from the gray literature and interview material. For the risk contamination and the investor preferences hypothesis event studies are used as well.

6 Drivers related to operations and management

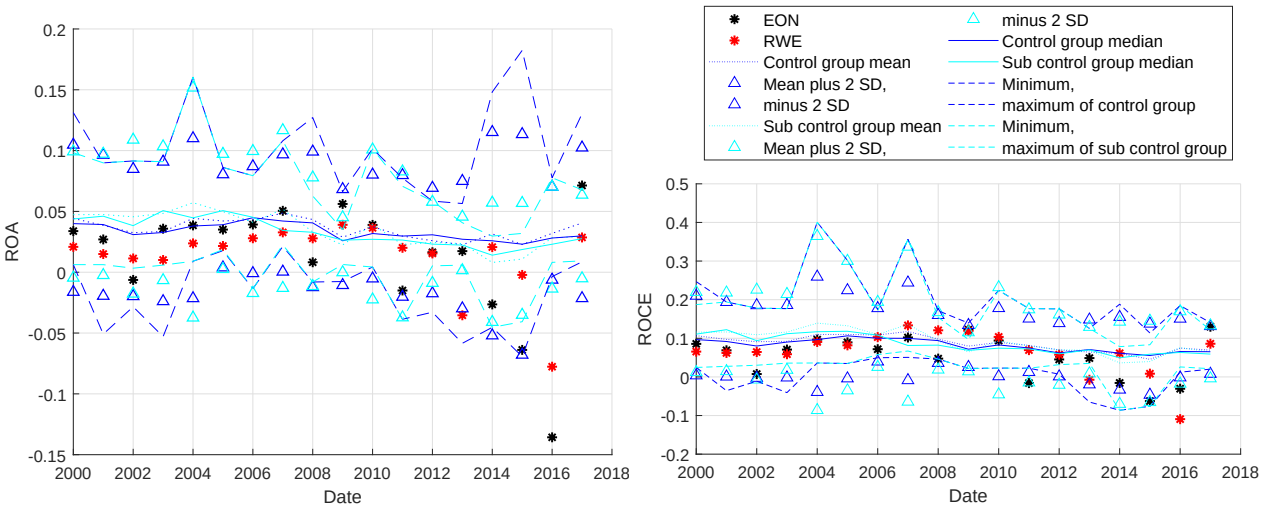
6.1 Poor performance before and better after divestiture

Poor performance pre-divestiture and a recovery afterwards is an indicator commonly linked to operational and management related drivers (see table 1). Starting in 2013 or 2015, depending on the control group used, return on assets (ROA) and return on capital employed (ROCE) of the two utilities fell out of the range of the control groups' minimums and the average minus two standard deviations. After the divestitures, in 2017, performance seems to have recovered (see figure 6.1).

6.2 Inefficient diversification, change in synergies, better fit with new managers' skills or management focus?

Most interviewees judged the increase in focus, with portfolios comprising conventional generation and trading on the one hand and renewables and grid infrastructure on the other, positively. Nobody, however, argued that the managers of the new companies had any specialised skill sets. In fact, in 2017 most managers at EON, RWE, Uniper and Innogy came from within EON's and RWE's non-renewable business units.[6] One can thus not argue that managers' specialised skill sets were a driver.
Instead of emphasizing skills, interviewees mentioned the potentially positive effect of a smaller range of tasks for management to focus on. One RWE executive said: "We face big changes in the industry - for example the

[6] Out of 17 managers at EON, RWE, Uniper and Innogy, 14 had a career background in the conventional energy business. 13 managers held positions at the respective parent firms EON or RWE prior to the split. 4 managers held outside positions, of which two where in the conventional energy business and two in IT-related roles. Only one manager at Innogy had a specialised background in renewable energies, albeit also acquired in-house at RWE (EON, RWE, Uniper, Innogy 2017).



(a) Return on assets (ROA).
Calculated by net income over total assets.

(b) Return on capital employed (ROCE).
Calculated by EBIT over (total assets less current liabilities).

Figure 6.1: Indicators for performance. Source: Own calculation based on Thomson Reuters Datastream.

development of smart infrastructure, the electrification of car transport, the self production of electricity. RWE could concentrate only on power generation, and Innogy on decentralised innovation." (Interview 16)

On the other hand, a number of interviewees claimed significant costs in terms of synergies lost, which are marked with negative numbers in table 2. For example, Uniper had taken over the trading section. "But then EON faced the challenge of procuring electricity for their retail segment, and selling their renewable electricity. So they opened another trading desk at EON." (Interview 12) An RWE manager said: "There were certainly synergies lost and these were quantified before the split decision. For example, if you have your own retail segment, this can hedge your electricity generation, as forward contracts are only liquid about three years into the future. Also, there are significant overhead costs for having two headquarters." (Interview 16)

In contrast, interviewees praised the intelligent synergistic decision of the EON-RWE asset swap, a second spectacular turnaround, announced in February 2018: in a complicated swap arrangement, EON would become Europe's largest operator of electricity grids and retail, and RWE would one of the continent's largest producer of green, but also conventional, energy. The specialisation on grid and services only (EON) and generation only (RWE), respectively, had been announced to lead to substantial scale effects: -500 million Euros a year due to double-staffing on the customer support side; EON announced job cuts of up to 7% (Buck 2018, Steitz and Käckenhoff 2018). RWE argued that size mattered in a renewables sector becoming increasingly competitive due to tariff-setting via auctions (Vaughan 2018, Wilkes 2018). Both EON's and RWE's share price reacted favourably.

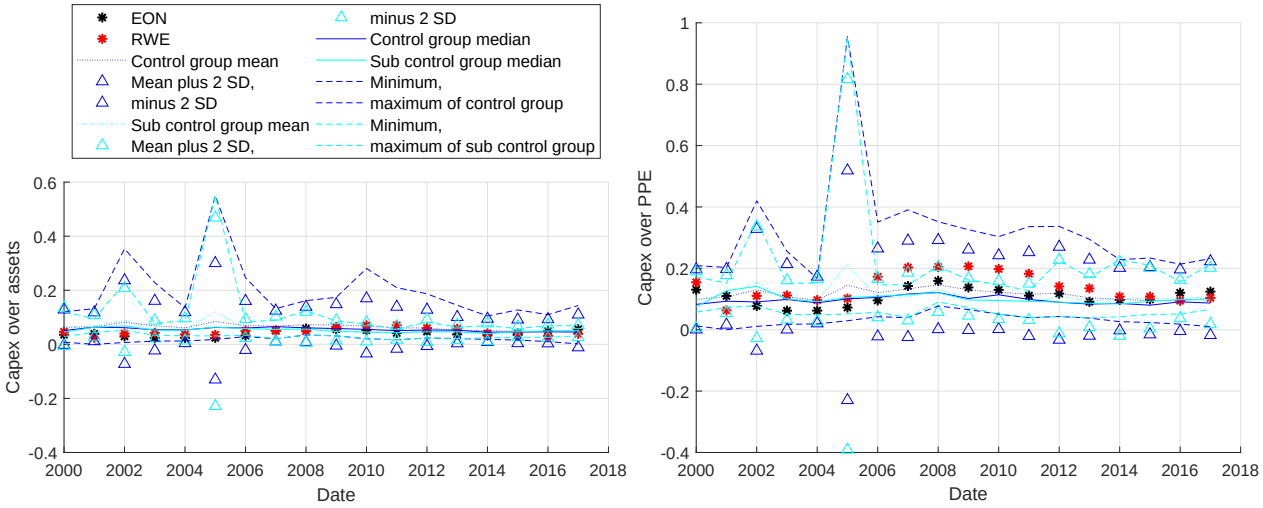
In RWE's case there might be synergies in operating conventional and renewable electricity assets together: "There are clear portfolio diversification effects of operating conventional and renewables together: when the wind does not blow, RWE can ramp up their gas-fired power plants." (Interview 9) The synergies might extend beyond day-to-day operating decisions: "There are significant policy risks inherent in electricity generation. If the government decides to push renewables today, RWE can expand there. If in five years policy makers slow down the transition and electricity prices increase, then investments in conventional generation could make sense again." (Interview 11) Indeed also EON, just two years before the first split, in 2014, had merged its conventional and renewable generation segments together arguing for synergies (Handelsblatt 2015-04-15).

In summary, there might be a benefit of having a smaller range of tasks; however, none of the other operational and management related drivers could be confirmed. In fact, for synergy reasons, a different segment separation seems to be more efficient and there even seem to be substantial dis-synergies of the 2016 divestitures. This is why operational and management drivers are rejected to be main drivers of EON's and RWE's divestitures.

7 Drivers related to investing

7.1 Over-investment due to asset substitution or managerial discretion

To confirm distortions related to investing due to agency conflicts, the literature has commonly used capital expenditure (capex) relative to assets or correlated with cash flows (e.g. Lamont 1997; Andrade and Kaplan 1998; Scharfstein 1998; Shin and Stulz 1998; Gertner, Power and Scharfstein 2002; Eisdorfer 2008). We compare capex over total assets, over property, plant and equipment (PPE) and correlated with cash flows with the control groups. If managers over-invested due to agency problems like asset substitution or managerial discretion, we would expect higher than average capex and higher correlation of capex with cash flows.



(a) Capital expenditure over total assets.

(b) Capital expenditure over property, plant and equipment.

Figure 7.1: Indicators for total capital expenditure. Source: Own calculation based on Thomson Reuters Datastream.

The figures reveal that investment was in line with both control groups except for capex on PPE at RWE pre-2012. The correlation coefficient of capex with cash flows from 2000 to 2017 is only moderate and even lower at EON and RWE than in the control groups: 0.46 for EON; 0.41 for RWE; 0.68 for all utilities. The result is robust to taking the more recent period from 2005 to 2014, which is possibly more relevant for the divestitures, and to looking at operating cash flows only. The overall numbers thus do not provide sufficient evidence for higher than average agency conflicts at EON and RWE.

7.2 Distorted investment due to rent-seeking or a biased capital allocation method

Next, we test for cross-segment subsidization due to rent-seeking or a biased capital allocation method. As renewables became a growth market and conventional generation was forced out of the market, if there were no distortions, one would expect investment to shift from conventional generation towards renewables.

Pre-2009/10, segment reporting on renewables is not available, but the existing literature (e.g. Kungl 2018) and interviewees point at decisions not being taken optimally. An equity analyst: "Between 2000 and 2005 the utilities had a fat harvest. They ignored renewable energy. They found the sector suspicious because it still needed subsidies. Coal was cheap, nuclear was profitable. So they were blind to anything new. They entered the renewables business too late." (Interview 14)

Interviewees also emphasized that the capital allocation method at the time fostered a bias toward the existing conventional segments. Both RWE and EON had allocated capital by adjusting discount rates according to segment, technology and country risk (Interview 6, 16, 19). The claim by Krüger et al (2015) that investment distortions occur simply due to the usage of one single cost of capital in the entire firm does not hold in this case. Rather, the pressures from powerful divisions might have biased assumptions and thereby indirectly affected discount rates.

For example at RWE, "it was a political bazaar. Everyone knew that the assets are very long-lived. So if you wanted more funds for your segment, it could help if you pushed certain assumptions about the long-term trend of power prices." (Interview 7). At EON, it was "every business segment for itself. [...] Every segment said we need amount X. Then the negotiation ensued. Now, on the contrary, strategy and management decide on an overall number for each segment and the segments only decide on the allocation between projects." (Interview 6) One EON manager thought that before the reform in capital budgeting, "we might have given high risk projects to much money, because we did not price the risks accordingly. Sometimes it was also the division managers that were screaming the loudest, who got the most of the funds." Interestingly, EON reformed the capital allocation method towards a more top-down approach in 2017, that is after the Uniper spin-off. In fact, none of the interviewees connected the splits in 2016 to problems in capital allocation.

Moreover, even though EON and RWE probably initially under-invested in renewables, other utilities that did not restructure under-invested on a similar scale: figure 7.2 shows that EON's and RWE's renewables share is a little below the mean but in line with the median of the control groups.

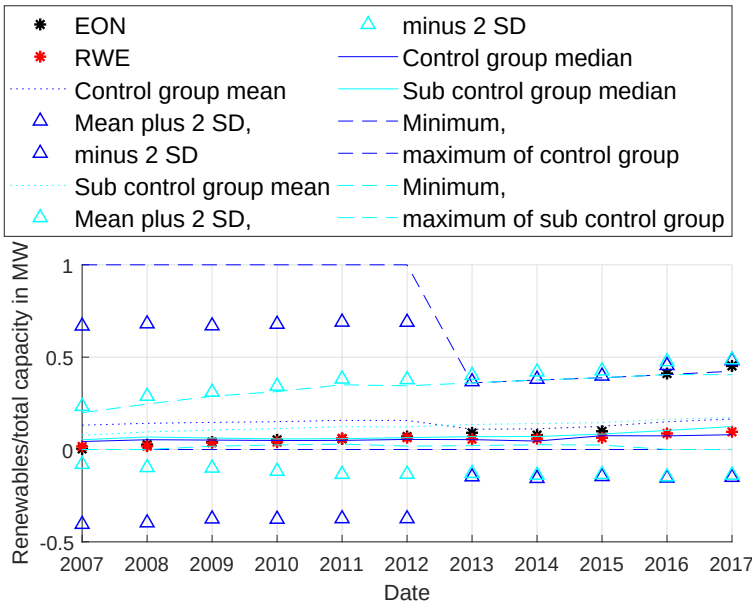


Figure 7.2: Renewables capacity in MW over total capacity.

Between 2010 and 2016 total capital expenditure at EON and RWE starkly decreased (see figure 7.3). Data series are not always available in all years due to reporting changes, but it is evident that investments in the conventional sector took big cuts: EON's investment in its 'generation' segment decreased by 78% between 2010 and 2015 and RWE's 'conventional power generation' by 81% between 2012 and 2016. Investment in German electricity distribution grid and sales, on the other hand, did not show any consistent trend. Investment in renewables at EON showed a peak in 2012 and then declined. At RWE, renewables capex almost tripled between 2008 and 2013, after which it collapsed by 60% by 2015 following the overall declining capex trend.

The annex shows capex over segment operating cash flows, sales, adjusted EBIT and depreciation, amortisation and impairments. What stands out are the high numbers of capex ratios in the renewables segment. Even though investment in renewables did not increase or it even decreased in absolute terms post-2010, it was still consistently higher than total firm investment and investment in conventional generation when compared to different measures of segment profitability and size. This means that utilities had acknowledged renewables as a growth market. After being hit by declining profits, they mainly reduced investing in conventional generation. But they eventually had to cut spending in renewables, too.

This is all the more understandable, since renewables were still free-cash-flow negative until around 2014 for various reasons (EON and RWE various years),[7] while parts of the conventional fleet, such as the remaining nuclear

[7] See also annex. The reason for why the renewables segments were still losing money in 2013 and 2014 is subject to debate in the literature

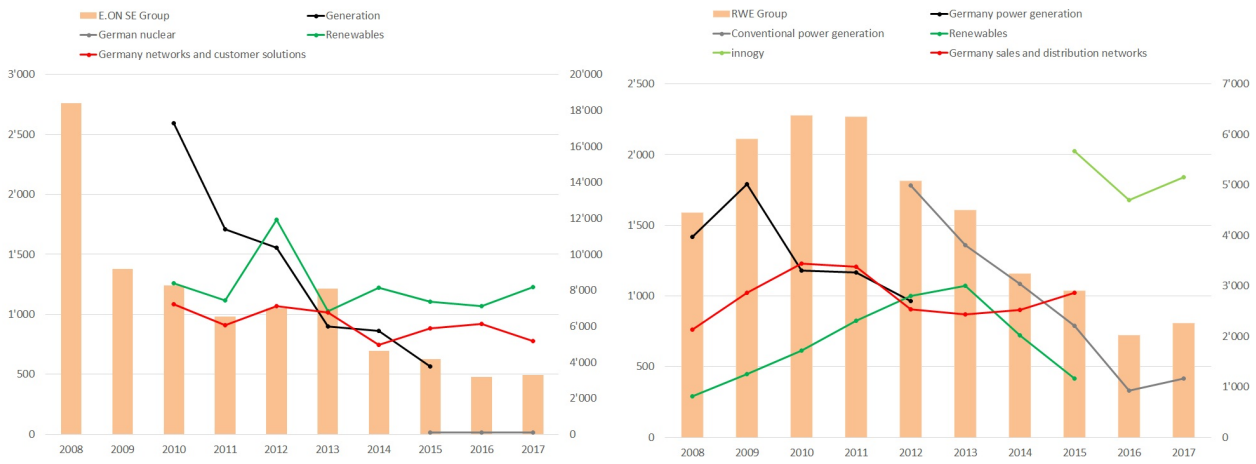


Figure 7.3: Capital expenditure on intangible assets, property, plant and equipment and investment property in EON's and RWE's main segments in EUR million. Source: own illustration based on EON and RWE annual reports.

power plants, were still profitable. Furthermore, returns in the conventional segments were not continuous: "In conventional energy production, we had to undertake some investments because of path dependencies" said one senior staff at RWE (Interview 7). RWE's CFO Bernhard Günther, when asked about why RWE would not close its conventional power plants more pro-actively, said that "lignite is a complex system where you cannot close individual plants so easily," hinting at the scale effects of operating German lignite power plants at full capacity close to the lignite mines (RWE 2016-03-08). Similarly, in a 2013 EON presentation to investors, management had justified investments in conventional and distribution assets by calling them "maintenance capex" that are "necessary to maintain existing assets in operation", "necessary to keep [the] license to operate" and "inflexible: to significantly reduce capex [we] would have to exit [the] business altogether". EON management announced that "discretionary capex" would by "2015 almost completely [be] allocated to priority growth areas: renewable energy, distributed energy, outside Europe" (EON CMD 2013).
Thus from around 2010, there were path dependencies in investing, but no systematic bias disadvantaging renewable energies due to agency conflicts, rent-seeking or a biased allocation method. Thus the question is rather why the firms could apparently not raise additional funds on the capital markets to invest into growth in renewables.

8 Drivers related to financing

8.1 Debt overhang

This section examines whether, in accordance with debt overhang, EON and RWE raised funds for growth or the retirement of debt and whether they had higher leverage prior to the divestiture as compared to their non-divesting peer group.

8.1.1 Funds raised for growth and retirement of debt

The raising of funds through divestitures could hint at different drivers: biased investment, risk contamination or at debt overhang (see table 1).
EON did not raise funds when Uniper had its stock-market listing in September 2016, but funding was accessed later: in March 2017, the new EON raised EUR 1.35 billion through a capital increase. This was used to partly fund the contribution to the public nuclear fund (see section on risk contamination). In June 2018, EON finalized the

and among practitioners. Factors might have been long lead times of offshore wind projects (Interview 12), delays in grid access of offshore parks (Spiegel 2011), unforeseen cuts in renewable electricity tariffs in Spain and the Netherlands (EON 2013, RWE 2013) as well as the planned scaling down of subsidies in Germany (Interview 6). Some interviewees also blamed a lack of experience in renewable technologies paired with the pressure to invest at any cost to make up for lost time at the utilities (e.g. Interview 16).

sale of its 46.65% stake in Uniper to its competitor Fortum for EUR 3.8 billion. EON stated that the proceeds would be used to fund growth in renewables and networks (EON 2018).
In October 2016, RWE sold 73.4 million shares of its holding of its subsidiary Innogy and another 55.6 million were placed through a capital increase by Innogy at the same time. RWE's stake in Innogy dropped to 76.8% as a result. Similar to EON, RWE announced that it would use the Euros 2.6 billion from the sale of Innogy shares to fund its share in the nuclear fund, while the 2 billion from Innogy's capital increase were intended for growth projects in renewables and networks (RWE 2016).

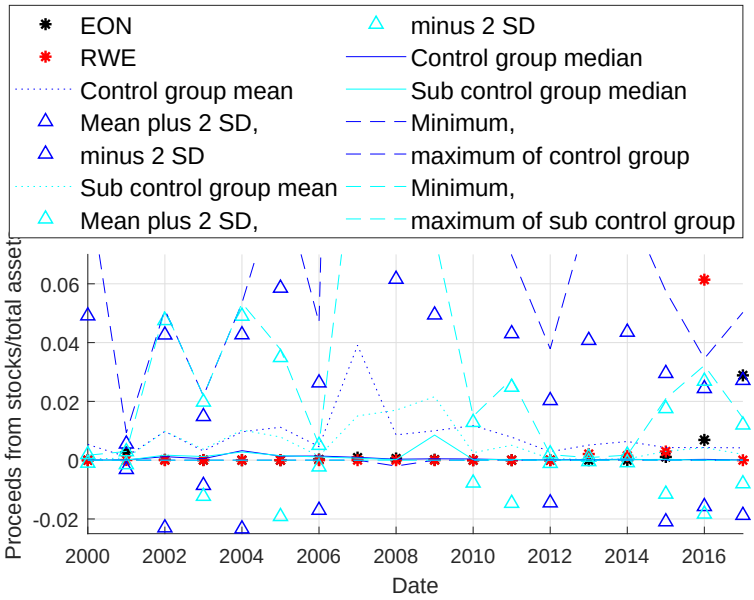


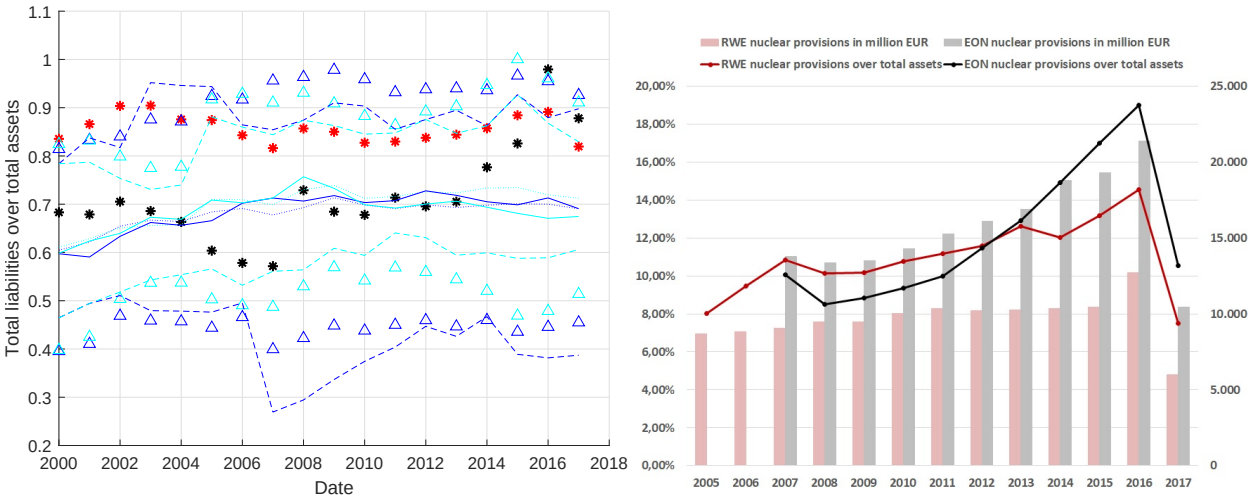
Figure 8.1: Proceeds from issuing stocks over total assets for different utilities. Source: Own calculation based on Thomson Reuters Datastream.

Figure 8.1 shows proceeds from stocks raised by EON and RWE over assets compared to the control groups. It shows very low issuance until 2015 and a spike compared to the control group for RWE in 2016 and for EON in 2017.[8]
RWE and EON thus had raised a considerable amount of funds directly and indirectly through the divestitures. They stated that they would invest the funds in growth and also, insofar as the nuclear funds contributions can be classified as debt, retire debt.

8.1.2 High leverage

Concerning long-term bond ratings, European utilities suffered from a wave of downgrades. Between 2005 and 2017 their average rating deteriorated from A+ to between A- and BBB+. EON's and RWE's ratings decreased in line with that. Debt and liquidity indicators are also in line with the control groups; EON and RWE net debt and long-term debt are even lower than average in the recent years (see annex).[9]
When looking at total liabilities over assets, the picture is different, however (see figure 8.2): EON's liabilities increased noticeably and RWE's increased slightly from a very high level between 2013 and 2015. The reason is that liabilities include provisions for nuclear dismantling and storage, whereas debt does not. Between 2007 and 2015 nuclear provisions increased by 40 and 16% in absolute terms and by 69 and 22% relative to total assets at EON and RWE respectively.[10]

[8] In the late 2000s, a few utilities had pursued a similar strategy to RWE, which leads to high the standard deviations during that time, which are evident in the graph: EDF floated its renewable subsidiary in 2006, which was followed by Iberdrola in 2007, EDP in 2008 and Enel in 2010. All intended to use the funds for growth and bought back the minority shares later.
[9] Other indicators, like the quick ratio, current debt to total assets and net debt to EBITDA, were tested, too, and not significant.
[10] For 2016 and 2017 ratios, total assets are calculated by still assuming the integrated company. As EON does not consolidate its Uniper holding, EON cum Uniper assets = EON assets + Uniper assets. Since RWE fully consolidates its Innogy holding, RWE cum Innogy assets = RWE



(a) Total liabilities over total assets. EON black, RWE red, control groups blue (for full legend see previous graph).

(b) Nuclear provisions in million Euro and in percent over total assets.

Figure 8.2: Nuclear provisions and overall liabilities. Source: own calculation based on Thomson Reuters Datastream and EON and RWE annual reports.

There is thus strong evidence for the debt overhang hypothesis - but only if one counts nuclear liabilities towards debt.

8.2 Appropriate gearing

The idea of appropriate gearing is that, by splitting up, the tax shield of debt increases due to the possibility to adjust debt levels more appropriately to the two henceforth separate firms. This has been argued for EON, for example, in J.P. Morgan's equity analyst report (Casali 2015).
Figure 8.3 shows that in 2017 interest over assets and interest times tax rate over assets was very close to or even lower than in 2015. This means that the overall tax shield did not increase in response to the divestiture and the appropriate gearing hypothesis can be rejected.

8.3 Asymmetric information

Authors have argued that going public reduces asymmetric information or that it is less relevant for one part of the firm leading to a better understanding and valuation of the separate firms. We search for a possible decrease in analysts' forecast dispersion or error or an increase in coverage by analysts post-divestiture. The figure reveals that there was indeed an increase in total coverage by analysts of EON cum Uniper and RWE cum Innogy. This, however, did not translate into a better EBITDA estimate or less dispersion end of 2016 and 2017 for EON and RWE: standard errors of estimates and standardized forecast errors increased for both. Uniper has a lower standard error but higher forecast error than EON. Innogy has both lower standard error and standardized forecast error than for RWE. Asymmetric information might thus have been lower only for Innogy as compared to RWE.
Why could it have been easier for analysts to value Innogy? In the next section it will be argued that RWE, EON and Uniper were to a certain extent risk-contaminated by the conventional generation portfolio.

8.4 Risk contamination

The test of the risk contamination hypothesis consists of four parts. First, the origin of the profit decline at EON and RWE is examined. If past losses are an indication of future expected losses, then the risk contamination argu-

assets + Innogy assets - RWE majority holding in Innogy assets of 76.8%. This is to avoid an exaggeration of the ratio due to the decreased asset base post-divestiture.

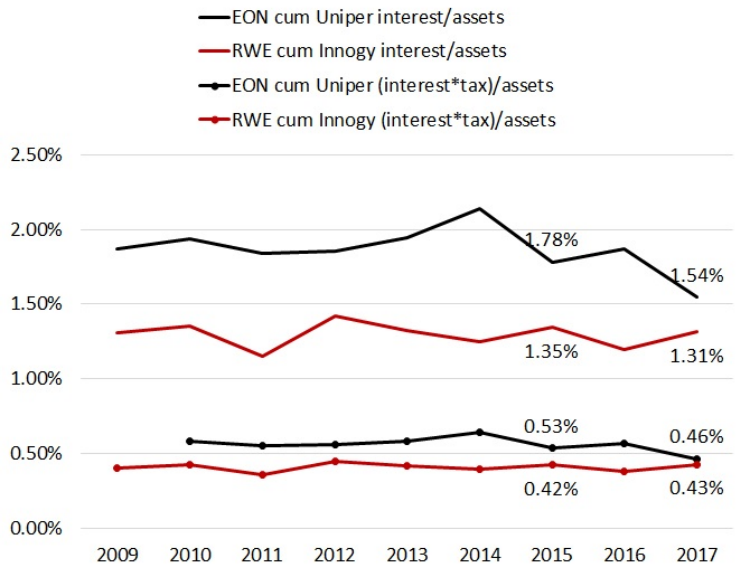


Figure 8.3: Interest over assets and interest times tax rate over assets. Source: Own calculation based on EON and RWE annual reports.

ment only makes sense if divestitures are structured such that the risky segments are shielded off. Second, stock market valuations of the pre- and post divestiture utilities are compared over time and to their peer group. If risk contamination was a driver, one would expect large valuation differences between parents and subsidiaries and an overall valuation increase post-divestiture. Third, a share price event study is conducted in order to find further possible sources of risk contamination. Fourth, interview results are used for triangulation.

8.4.1 Sources of profit decline

Net income at EON and RWE closely followed losses from impairments. Impairments over book asset value increased from around 2011 to above average or median, but still below the control groups' maximums (see figure 8.5). Looking at the overall sum of impairments, EON wrote off 20 billion Euros between 2011 and 2015, or 13% of 2011 book asset value. At RWE, 17 billion Euros, or 19% of their 2011 book asset value were written off (EON and RWE, various years).

In which segments did the impairments occur? Conventional generation segments were hit hardest at both EON and RWE. Of EON's 2011-2015 impairments, 74% were in the conventional generation unit, 33% of which due to low power prices. The renewables segment was responsible for only 5%; other segments contributing were trading and gas exploration with about 4% and 9%.

Of RWE's 2012-2015 impairments, 82% occurred in the conventional generation segment, 59% of which were due to low power prices and shut-downs in Germany and the Netherlands. The renewables segment was responsible for around 9% of impairments, mainly due to regulatory changes in the Netherlands, Spain and Poland and due to delays in network connections and increased investment costs at German offshore wind parks. About 5% was in the German supply and distribution networks segment.

It can be assumed that for both utilities, conventional generation impairments concerned mainly gas-fired and hard-coal-fired power plants due to low electricity prices, as these have the highest marginal costs.

Nuclear capacity was also affected due to the government-required shut-downs at least in 2011, 2015 and 2017. Right after the accident in Fukushima, the German government first put the seven oldest reactors and the disputed nuclear power plant Krümmel on a moratorium and then permanently mothballed them, two of which were owned by EON, two partly by EON and two by RWE. Two were shut down in 2015 (by EON) and 2017 (by RWE and EON).[11]

[11] The remaining seven power plants will be shut down by 2022.

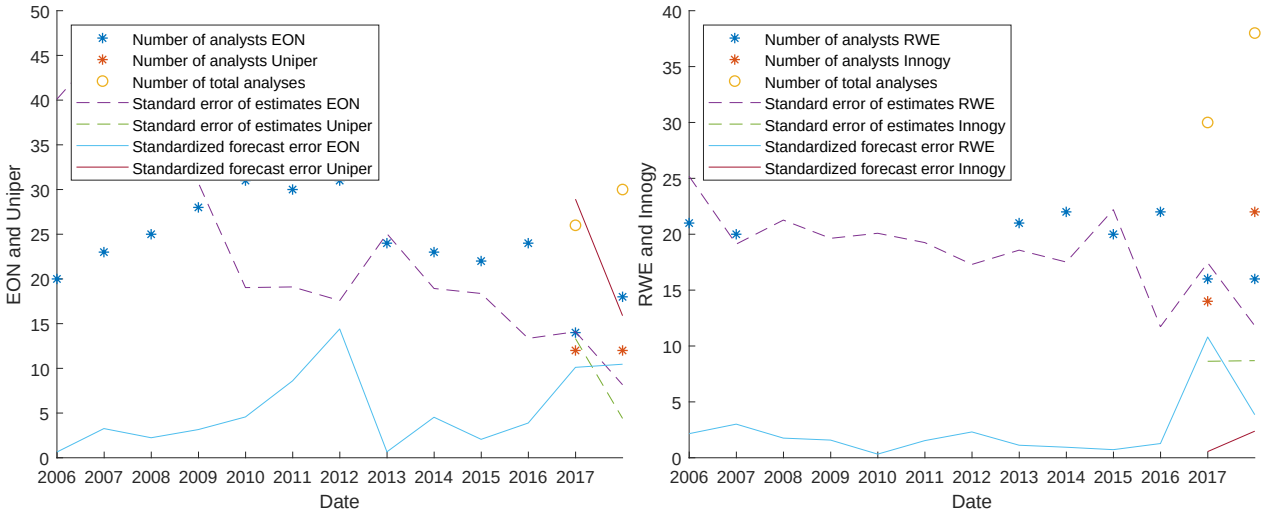
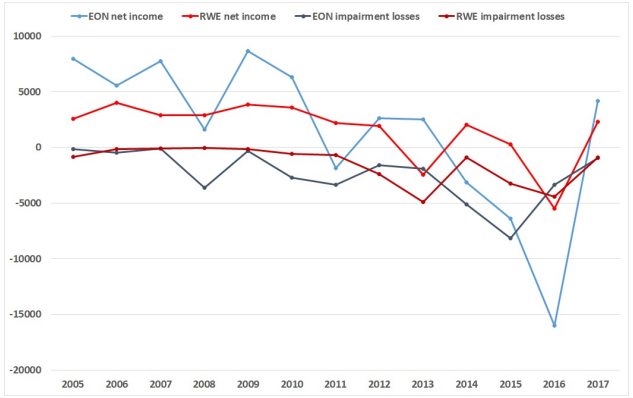
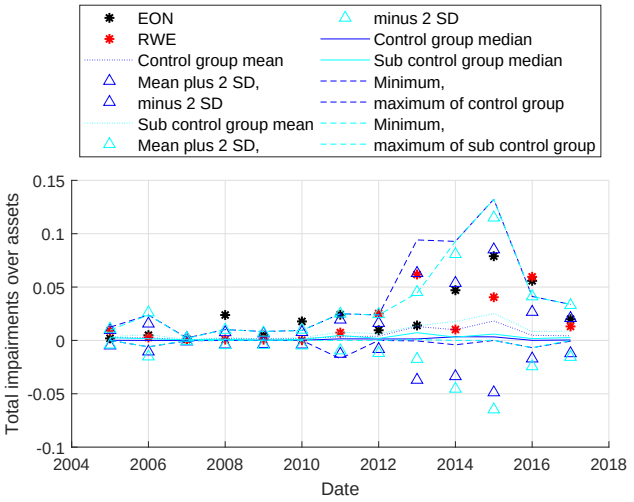


Figure 8.4: Analysts' coverage, standard errors and standardized forecast errors for EON, Uniper, RWE and Innogy. The standard error of estimates is calculated as the standard deviation of estimates/number of analysts and the standardized forecast error by the |mean EBITDA estimate - historical EBITDA|/standard deviation of the estimates.



(a) Net income and total impairments.



(b) Impairments over book asset value.

Figure 8.5: Net income, total impairments and impairments over book asset value. Source: own calculation based on Datastream.

While these shut-downs certainly figure among the impairments, they apparently played a minor role: record impairments were not in 2011, when by far the most nuclear power plants were retired, but later.
Analysing pre-divestiture impairments thus showed that high losses occurred mainly in fossil generation and to a limited extend in nuclear - both parts of the firms that were shielded off from the growth (renewables) and stable (grid infrastructure) parts of the firms through the divestitures.

8.4.2 Valuation effects

If EON and RWE divested to attenuate risk contamination, they would have needed to shield off the risky assets, which were in danger of pulling the rest of the firm into default. One could thus assume that the pre-divestiture integrated firm was undervalued. With the divestiture, the low-risk assets' market valuation increases due to the limited liability effect, while the high-risk assets' valuation decreases due to the loss of co-insurance from the low-risk business. Overall, the whole firm's valuation improves, if the limited liability effect dominates the loss of the co-insurance effect. Taken together this would be evidence for the risk contamination hypothesis.

A first step is to look at the annual market to book asset value of European utilities in figure 8.6. RWE and especially EON had relatively low values in the early 2000s, average valuations from around 2007, which then again deteriorated from around 2013/14. The 2015 valuations were below average though still in the range of both control groups.

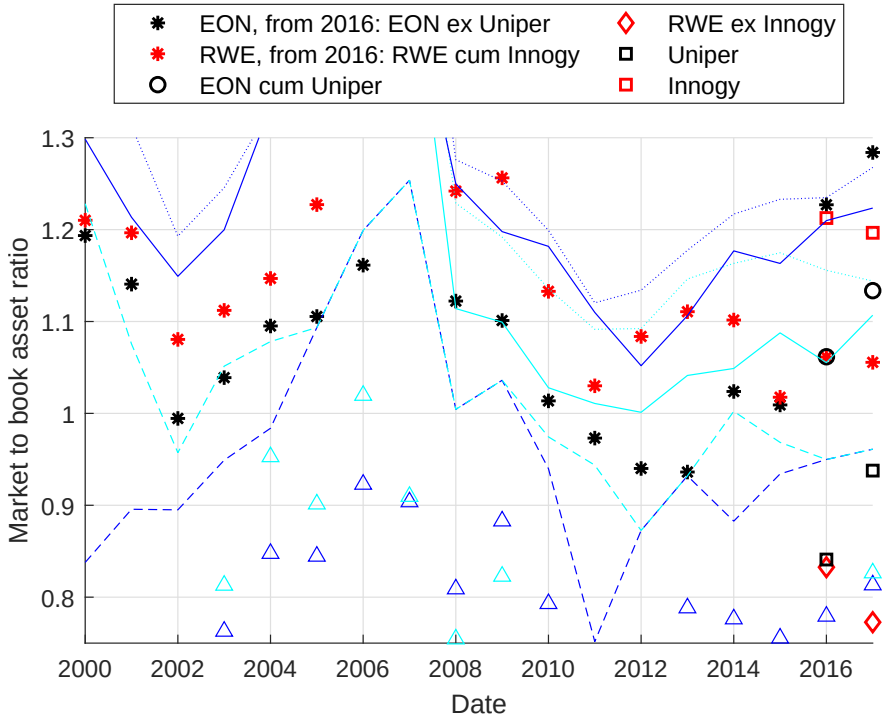


Figure 8.6: Market to book asset ratio, calculated by (market price year end · common shares outstanding + book value of total liabilities)/book value of total assets. Source: own calculation based on Thomson Reuters Datastream.

To analyse the valuation effect of the divestitures, we can compare EON cum Uniper and RWE cum Innogy 2015 values (denoted by circles 8.6) with 2016 and 2017 (black star for EON, red circle for RWE).[12] EON cum Uniper's valuation improved from 1.01 to 1.06/1.13 (2015 black star compared to 2016/2017 black circles), as did RWE cum Innogy's, from 1.02 to 1.06/1.06 (2015 red star compared to 2016/2017 red circles). The best valued firms are Innogy (1.21/1.20) and the new EON (1.23/1.28), whereas Uniper (0.84/0.94) and RWE ex Innogy (0.83/0.77) have low market to book values, clearly below the minimums of their control groups in 2016/17.[13] This is first evidence for the risk contamination hypothesis.

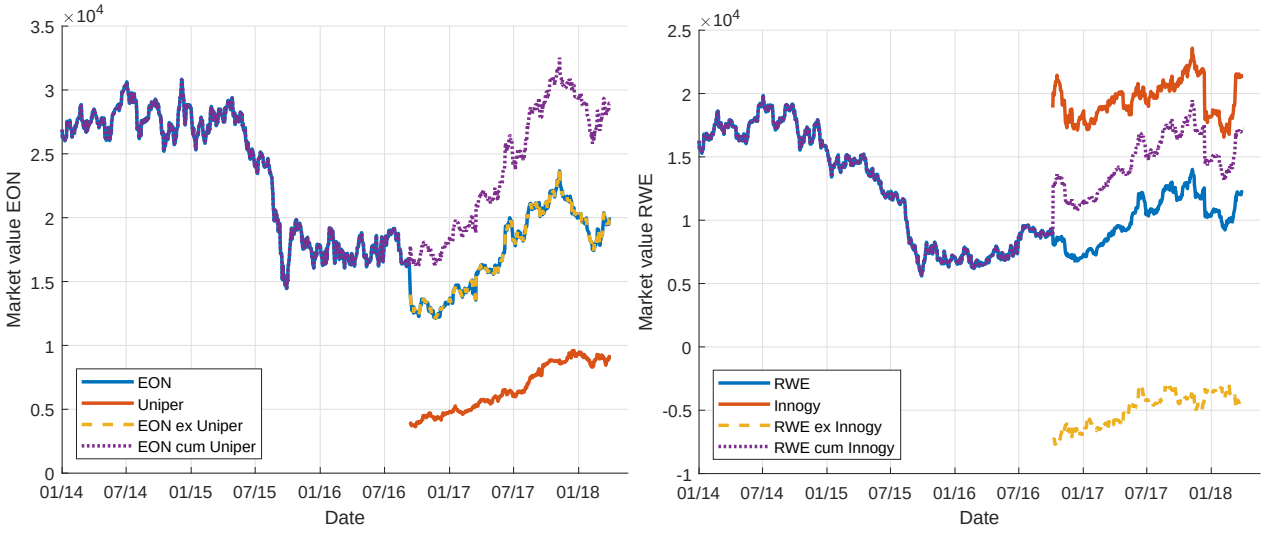
Comparing pre- and post divestiture valuation of the listed companies reveals that EON's valuation benefited more (1.23 and 1.28 in 2016/17 compared to 1.01 in 2015) than RWE's (1.02 to 1.06). This illustrates why EON's split, being the first of the two divestitures, was strategically more intuitive for the existing management: they got to be managers of a new firm with an improved valuation. RWE's CEO Peter Terium, on the other hand, had to make himself CEO of the subsidiary Innogy in order to be still heading a firm with high growth potential.

Figure 8.7 plots the daily development of market capitalisation at the two utilities. Two effects are striking. First, RWE ex Innogy's implicit negative valuation: on the day of Innogy's IPO on October 7, 2016, its market cap was at -7.3 billion Euros and at the beginning of 2018 still between -3 and -4 billion. Second, the jump in market value of RWE cum Innogy of about 45%, while EON cum Uniper only valued up by less than 9%.

This is also illustrated in graph 8.8 showing market capitalisation prior to and on the days of Uniper and Innogy going public. The full calculation is described in the annex. The legend entries in brackets rest on an arbitrary

[12] Calculation of the ex and cum values is done as described in the annex. EON cum Uniper is a benevolent estimate, as it includes Uniper's full market value. It assumes that shareholders anticipated the complete sale of EON's Uniper stake, as announced in December 2014, even though EON still held a minority stake of 46.65% until June 2018, when it sold to Fortum.

[13] In 2017, Innogy, deteriorates compared to Uniper, which is likely related to low profits in their UK segment (Innogy 2017), whereas Uniper values up, pulling EON cum Uniper with it, due to recovering electricity prices (Uniper 2017).



(a) EON, Uniper and combined market value

(b) RWE, Innogy and combined market value

Figure 8.7: Market value calculated by market price · number of common shares outstanding. Source: own calculation based on Thomson Reuters Datastream.

assumption: that Uniper's value halved and Innogy's value doubled by going public. This assumption would be in line with the risk contamination argument: the Uniper segment was co-insured by the rest of EON; it risk-contaminated EON. By going public it lost the insurance. Innogy was co-insuring the rest of RWE; it was risk-contaminated by the conventional business. By going public it lost the risk contamination. The graph shows that such an assumption would be consistent with the observed valuations.

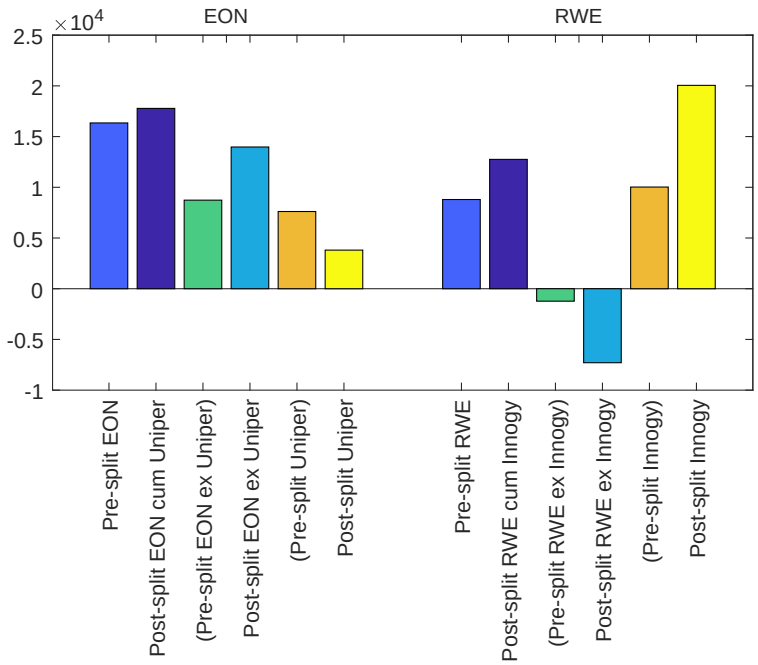


Figure 8.8: Market values on day -1 and 0 of Uniper's and Innogy's listing. Source: own calculation based on Thomson Reuters Datastream.

The difference between Uniper's positive and RWE ex Innogy's implicit negative valuation might be surprising at first glance, since the two have very similar business models. However, first, RWE ex Innogy's valuation is only hypothetical and the result of Innogy's very high valuation. Uniper, in contrast to RWE ex Innogy being a real traded firm, logically must have a positive valuation.

A second explanation is that at the time of the splits, Uniper was indeed more attractive than RWE ex Innogy.[14] Why might Uniper be more attractive? The most obvious difference: Uniper did not operate any nuclear power plants. EON kept the nuclear segment and in turn EON cum Uniper might have benefited less from the risk separation effect than RWE cum Innogy.

8.4.3 Event study on further sources of risk contamination

For the share price event study, events from January 2013 until November 2016 were collected.[15] Google news, the search functions of eight major German papers (Der Spiegel, Frankfurter Allgemeine Zeitung, Handelsblatt, Manager Magazin, Tagesspiegel, Sueddeutsche, Welt, Zeit) and the international edition of the Financial Times were used to identify events. Initial keywords were "EON" and "RWE", and events were tracked with varying keywords thereafter.

Overall, 26 events were identified that could possibly have had an impact on EON's and RWE's default risk. Four events had to be discarded because they coincided with a quarterly and an annual report publication, an RWE dividend payment and the sale of EON's energy from waste segment. The two divestiture announcements and the two divestitures themselves (ex dates) were also added to the events, giving a total of 26 events tested.

A negative share price reaction to an event does not prove an increase in default risk and risk contamination, but points more generally at investors seeing growth potential lost. To corroborate the risk contamination argument, it therefore is interesting to also look at events that led to a reduction in uncertainty. If they cause positive share price reactions - regardless of or in contrast to their likely effect on future returns - this might support the risk contamination argument, because utilities' had been exposed to risk involving high possible costs and a decision eliminating uncertainty relieved the share price of some of the downside priced in earlier.

The events can be classified into three types of mainly policy related categories:[16]

1. **Four events related to the divestitures**: the two utilities' announcements to split (November 30, 2014 and December 1, 2015) and the two divestitures (September 12 and October 7, 2016). All hypotheses would predict a positive effect of the announcements on the parents' share price. Assuming risk contamination, one would also expect the parent to devalue on the divestiture day if it contains the 'contaminated' assets and to value up otherwise.

2. **Four events related to renewable energy policy reforms**. In January 2013, the German ministry for the environment launched efforts to reduce the power price for consumers by enforcing limits to renewable energy construction (Handelsblatt 2013-01-28). In June 2014, the Bundestag decided on a renewable energy law reform, among other things limiting feed-in tariffs for renewable energy (BMWi 2014-06-27).

   It is expected that changes in favour of renewable energies would increase utilities' risk due to their fossil- and nuclear-heavy portfolio and therefore have a negative impact on their share price. Events reducing uncertainty might also have a positive effect on share prices.

3. **Five events related to climate policy**. In November 2014, Energy and Economics Minister Sigmar Gabriel presented first ideas for a CO_2 levy on coal power plants in order to reach Germany's internationally agreed 2020 climate targets (Handelsblatt 2014-11-24). The negotiations with utilities and unions turned out to be difficult and finally also the heads of lignite-rich states allied against Gabriel. In June 2015, the levy was

[14] J.P. Morgan's valuation of enterprise value over EBITDA supports this: Uniper estimates for end 2016 and 2017 are higher than the implied values for RWE ex Innogy and also than EON's German nuclear unit (see annex). Enterprise value over EBITDA is a useful indicator because JP Morgan uses a sum of the parts (SOTP) analysis, which allows to disentangle estimates for the different business segments. So the RWE ex Innogy estimate is not merely enterprise value and EBITDA estimate of RWE minus 76.8% of Innogy's but it corresponds to the specific SOTP business segment sub-items.

[15] January 2013 is about two years prior to the EON-Uniper spinoff announcement. EON stated that the strategy had been developed over one year. RWE had publicly rejected the possibility of a split until mid-2015. The last event included is Innogy's IPO.

[16] Although changes in commodity prices like electricity have a high impact on utilities, no event-like news item could be identified. However, it has already been established that EON and RWE suffered more than their peers from impairments, mainly due to depressed power prices. This event study only identifies further possible sources.

replaced with an about 800 million annual premium in order to retire about 2.7 Gigawatt of lignite capacity between 2017 and 2020 (Tagesschau 2015-06-24, Frankfurter Neue Presse 2015-06-27).

Events making the introduction of a CO_2 levy likelier are expected to have a negative impact on utilities' share prices, especially on RWE, which has a higher share of lignite. Events reducing uncertainty might also have a positive effect on share prices.

4. **Eleven events related to nuclear energy policy changes and news**. Due to the planned complete exit from nuclear energy by 2022, the question arose of whether utilities would be able to cover all costs for dismantling power plants and storage of nuclear waste. EON and RWE had 16.6 and 10.4 billion Euros in provisions for nuclear dismantling and storage as liabilities on their balance sheets. Together with the other three operators of nuclear power plants in Germany (Vattenfall, EnBW, and a small share by the Munich municipal utility), provisions added to 38.3 billion (Warth und Klein 2015).

   Policy makers had three main concerns: first, since on the asset side, the use of the nuclear provisions was not ring-fenced, they could fall victim to impairments or bankruptcy. Against the backdrop of utilities' already shrunk balance sheets and market valuations, this suddenly seemed like a real risk in 2015 (Irrek and Vorfeld 2015).

   Second, even if the provisions were available, it was unclear how much of the cost they would cover. Worldwide no experience existed with dismantling and storing nuclear equipment for several hundred of thousands of years. In a study on different nuclear financing options, it was estimated that even infrastructure projects with a long track record have cost over-runs of 35-1,500% (Küchler et al 2014).

   Another factor adding to the uncertainty in estimates were discount rates. Because the bulk of the costs would arise until at least 80 years into the future, the real discount rate - interest earned minus inflation - had a high impact. While utilities used 4.58%, a report commissioned by the Ministry for Economics and Energy tested different scenarios ranging from 2.03 to 4.53% and obtained estimates between EUR 32.4 and 77.4 billion, i.e. up to two times or almost EUR 40 billion higher than the utilities' provisions (Warth und Klein 2015).

   For these reasons cost estimates covered a wide range. The graph below gives an overview of estimates by various sources.

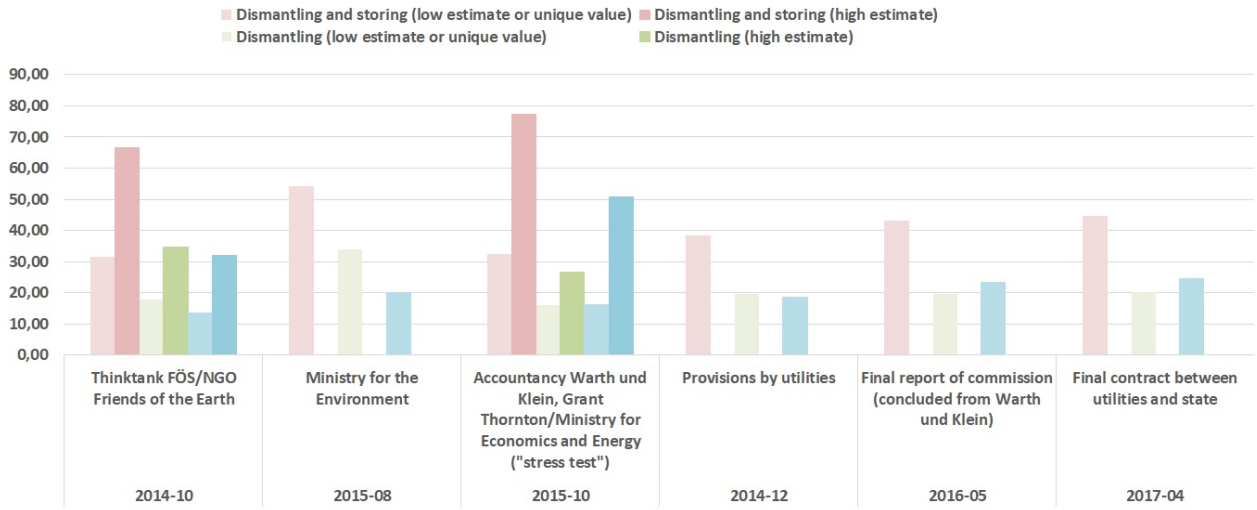


Figure 8.9: Cost estimates for nuclear dismantling and storage to be covered by five German utilities in billion Euros, all 2014 prices. Sources: own illustration based on references.

Third, and in addition to these economic issues, utilities and government disagreed about the legal aspects regarding the division of costs between industry and state. The four major utilities published a joint report

emphasizing the role of the state in ensuring legal security and argued that cost increases due to changes in regulations should entirely be covered by the state (Freshfields Bruckhaus Deringer 2015). The Ministry for Economics and Energy, on the other hand, stated that all costs are borne entirely by utilities (BMWi 2014).

In line with that, when EON announced the Uniper spin-off in late 2014, Minister Gabriel threathened with a "parents are liable for their children law". The law - indeed passed later in October (DW 2015-10-14) - would make all companies eternally liable for their nuclear operations and waste, in contrary to existing regulations according to which companies were only liable for five more years following a legal separation.[17] EON would thus have remained liable for a segment that was supposed to be operated by Uniper. In September 2015, EON's supervisory board agreed to change their initial plans and keep the nuclear segment with EON (Handelsblatt 2015-08-13).

During the coalition talks in November 2013, the Social Democratic Party (SPD) had first brought up the idea of a state-run fund to secure nuclear provisions as had been set up in France and Switzerland. The utilities initially opposed the idea of an external fund. From their point of view, using nuclear provisions as a debt like item for investments dominated the option of cashing them out.

When political pressure increased, however, and numbers discussed were suddenly much higher than existing provisions, a fund seemed appealing. Utilities offered to immediately pay their existing provisions into a fund in exchange for the state taking all responsibility for operating existing nuclear plants as well as ensuring dismantling and storage. The government initially demanded that the existing provisions be secured, but utilities remain responsible for the operation of the plants as well as for any cost increases of dismantling and storing (Welt 2013-11-14, Spiegel 2014-05-11).

Between 2014 and 2016 a number of reports were published two of which, commissioned by the Ministry for Economics and Energy (BMWi), turned out to be the most influential: the legal opinion by Becker Büttner Held (2015) that nuclear provisions were not sufficiently safe unless transferred to an external fund, and the report by Warth und Klein (2015) with cost estimates ranging from 6 billion less to 40 billion more than utilities had provisioned.

In November 2015, the government set up an expert commission tasked with reviewing the financing for the phase-out of nuclear energy. The final "law on the reorganization of responsibility in nuclear waste management" reflected the recommendation by this commission, which in turn reflected the two BMWi reports. It was a compromise: for storage, utilities paid 24 billion - 7 billion more than provisioned - into a state-run fund (10.3 billion by EON and 6.8 billion by RWE) in exchange for ridding themselves of any storage responsibilities. Dismantling of nuclear power plants remained the utilities' responsibility and on their balance sheets.

Negative share price reactions are expected for events that made utilities' cashing out of nuclear provisions or their unlimited liability in case of cost increases likely. Events reducing uncertainty might also have a positive effect on share prices.

Figure 8.10 plots EON's and RWE's share price with lines representing events in the different colours. It shows a widening gap between the utilities and the Stoxx Europe 600 index compared to their January 1, 2012 prices. Renewable energy related events are spread throughout 2013 and 2014; climate policy related events occur mainly in 2015. Nuclear related events started in late 2013 and intensified in the second half of 2015, coinciding with share prices plummeting.

The annexed table lists all events with their expected impact and the regression results. The estimation method is also described in the annex, as well as the result of a Brown Warner test with randomized event dates.[18]

[17] Indeed the Swedish parent Vattenfall in 2012 had cut links with its German subsidiary, supposedly in order to no longer be liable for German nuclear power (Casali and Hawkins 2016).

[18] Results were also tested and found mainly robust for event and estimation windows of 1-11 and 20-200 days respectively. The specification chosen was one day for the event period and 100 days for the normal period. The relatively short event period is justified to distinguish between events that follow each other closely like the ones in late 2016.

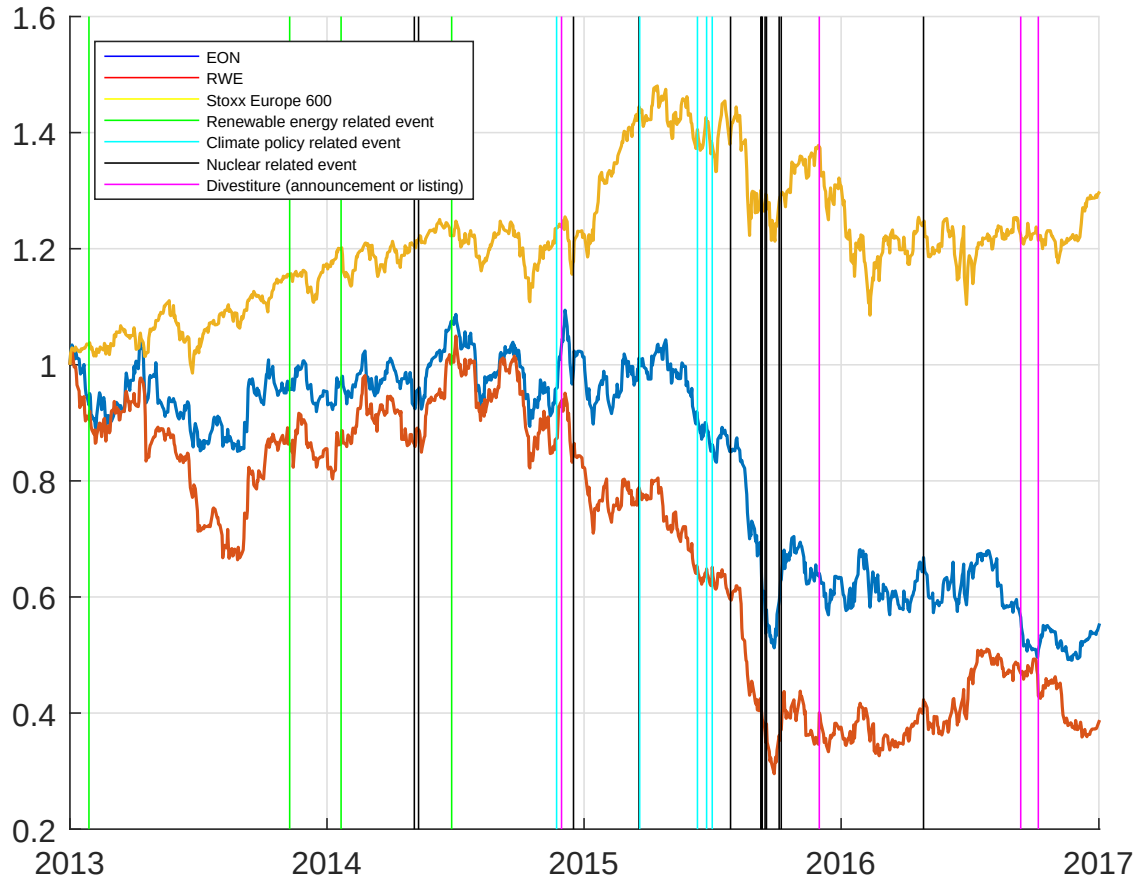


Figure 8.10: EON and RWE price of common stock and Stoxx Europe 600 normalized by their January 1, 2013 value, and event types in different colors. Source: own illustration based on Thomson Reuters Datastream.

The results of the event study are as follows:

1. **Positive significant effect of divestiture announcements**. As predicted, there is a significantly positive share price reaction on the Uniper spin-off announcement day for EON of 4.1% abnormal returns compared to the Stoxx 600 Europe Index and of 16.5% on the Innogy carve-out announcement day for RWE. This indicates that shareholders expected positive value creation from the divestitures and is in line with all hypotheses discussed.

   Regarding the ex-date effects, both EON's and RWE's reaction to the Uniper spin-off was negative but insignificant. They both reacted significantly, though, to the Innogy carve-out. EON's share price valued up by 3.7% compared to the index, whereas RWE devalued by 7.0%. The reason for these effects might be that only the RWE-Innogy split offered perfect risk separation. The split drove many RWE investors away from the now fossil and nuclear heavy stock. Many investors seemed to have gone Innogy and some to the relatively cleaner competitor EON.

2. **No impact of renewable energy related reforms**. The two utilities' stock prices did not react significantly to any of the renewable energy related events and often with returns opposite to the predicted effects.

3. **Limited impact of climate policy, finally in favour of RWE**. Regarding climate policy, the government's first efforts in late 2014 and early 2015 did not seem to weigh on EON's or RWE's share price. The final decision not to implement any CO_2 levy and instead reward the retirement of lignite plants, however, gave a significant boost to RWE's share price. When news came out (June 24, 2015), abnormal returns compared to the index where 2.5%; when the full compromise was published (July 2, 2015), the reaction was 5.8 percent. Given that RWE announced its divestiture almost half a year after this favourable decision, immediate fears of climate policy cannot have played any role.

EON's lack of a reaction makes sense: due to its lower relative share of lignite, it was less threatened by a levy.[19]

4. **High impact of nuclear related events**. From May 2014 till September 2015, nuclear related events were insignificant. This changed in September 2015:

   (a) **Negative impact of EON keeping nuclear**. On September 9/10, investors strongly punished EON for the decision to keep its nuclear segment with significantly negative abnormal returns of 2.4 and 5.8%.

   (b) **Negative impact of higher cost estimates**. Four days later, Spiegel leaked the results of the "stress test", the Warth und Klein report commissioned by the Ministry: allegedly an up to 30 billion funding gap for overall nuclear provisions existed, as utilities were too generous in their discount rate estimates (Spiegel 2015-09-15, Wirtschaftswoche 2015-09-17). Abnormal returns compared to the Stoxx on that day were -6.6 at EON and −3.5% at RWE.

   (c) **Positive impact of lobbying efforts**. Their stocks stayed in free fall, speculation about the real cost of the nuclear built-down intensified and utilities worried about the rating implications of their devaluations, until on September 17 the government intervened. Minister Gabriel declared that he did not to know about a gap of 30 billion, that the report was not finished yet and that leaked results were "irresponsible speculations" (Spiegel 2015-09-19). The share prices started recovering with significant positive abnormal returns of 8.2 (EON) and 1.0 percent (RWE).

   (d) **Positive impact of resolution of nuclear risk**. When the Warth und Klein study was published on October 8, one could still read about a possible funding gap in the worst case of even EUR 40 billion. Share prices did not react to it though and media painted the results in a positive light: "Germany says firms set aside enough nuclear decommissioning funds" titled Reuters (2015-10-10). Policy makers had successfully signalled that the utilities were too big too fail. And indeed, when the nuclear commission published their recommendation on the division of costs and liabilities on April 27, 2016, while EON and RWE complained that it "placed too much of a strain [...] on their economic capacity" (FT 2016-04-27), their share prices showed significant positive abnormal returns of 3.0 and 5.3%. This corroborates the argument of risk contamination by the nuclear segment. Even though the amounts to be paid into the fund by EON and RWE (10.3 and 6.8 billion) were each more than one billion or 13 and 22 percent above their provisions for nuclear storage, they were moderate enough that the market remunerated the liability cap on storage cost (EON, RWE 2015, 2016).

The event study establishes strong evidence for risk contamination from the nuclear segment. Supporting evidence is the high amount of nuclear costs discussed, the market's negative reaction to the nuclear segment staying with EON and to the alleged funding gap, EON cum Uniper's lack of valuation increase on the ex date, the policy makers' hesitation between a polluter-pays-all- and a too-big-too-fail-attitude and the market's relief at the costly but risk-reducing nuclear commission proposal.

8.4.4 Interview results

Fifteen out of 20 interviewees thought that the utilities' decision to split was driven by some sort of risk contamination.

Outsiders attributed a big role to the nuclear risks. As one equity analyst put it: "The utilities were confronted with two main problems: the flooding with renewable energies resulting in a drop in electricity prices and the issue of the nuclear exit. In 2014, they were going towards a valuation of zero - the whole companies were worth less than their grid segments. So either the market's valuation was totally wrong or there were big risks due to insufficient

[19] For both utilities, of course, climate policy considerations in general might have played a role for the divestiture decisions. In 2014, European CO_2 prices were on a record low, however, the utilities might have anticipated the EU Commission's efforts to reduce certificate amounts. But concrete steps in this direction were only taken from late 2017.

nuclear provisions. To be honest, the former was exactly the situation before the nuclear commission resolved the problem in favour of the utilities." (Interview 3)
Among the utility insiders, some staff members were equally outspoken: "The spin-off announcement was a shock for the whole staff at EON. We quickly understood that it was about nuclear energy. They wanted to create a bad bank for the liabilities. That was quickly blocked with the 'parents are liable for their children' law. Otherwise, if it had been too expensive, you could have let go of Uniper and after five years you're off." (Interview 10)
"RWE was worried that the nuclear liabilities would drag down the whole shop. Then there was EON's failed and naive move. So we learned." (Interview 7)
EON managers interviewed were more cautious. EON publicly never spoke about any risk-related drivers, let alone nuclear liabilities (EON 2014-11-30). RWE, on the other hand, put emphasis on their responsibility for nuclear liabilities. During the investor phone call on the divestiture announcement day, CEO Peter Terium argued that RWE would increase "visibility of the downstream and renewables business that have been overshadowed by the conventional business" and benefit from increased financial flexibility, as it could sell further Innogy shares if liquidity was needed, while assuming "full responsibility for nuclear liabilities" (RWE 2015-12-01).
Interviewees judged RWE's the more successful strategy, but only because EON's move was altered by policy makers: "EON wanted to bring nuclear into the spin-off deal - that would have been a successful move. But RWE's strategy was much better in the end: the good part was not burdened by nuclear. And from the point of view of policy makers, RWE's liability mass did not decrease. If liquidity was needed, they could always sell Innogy for cash." (Interview 3)
RWE killed two birds with one stone: separating the risks and as a result being able to raise money for the nuclear cash-out. But it came with the price of a business model that was unsustainable in the long-run and therefore only a temporary solution: "RWE could not survive without Innogy. So they said: why not swap with EON?" (Interview 19) With the asset swap announced in 2018, RWE will obtain both EON's and Innogy's renewables assets in exchange for the grid- and customer-related part of its own Innogy share.
In April 2016, the nuclear commission had lifted a chunk of the risk burden by capping storage costs. The compromise was appreciated by investors, because costs for storage were considerably more uncertain than for dismantling (JP 2015-06-21, Interview 11). With the storage cost capped, RWE in the end did not have to sell any further Innogy shares - the IPO and the initial equity sale sufficed. The new EON was able to raise capital to pay off its nuclear storage liabilities. When wholesale power prices recovered in late 2017, this benefited EON's nuclear segment and Uniper: "In hindsight the EON spin-off was not so bad, because nuclear plants make good money now." (Interview 19)
In summary, there is strong support for risk contamination based on the firms' and subsidiaries' valuations pre- and post-divestiture, a share price event study and interviews. Likely sources of risk contamination were further losses by fossil fuel-fired power plants and the acute risk of unmanageably high nuclear dismantling and especially storage costs linked to the nuclear exit.

9 Investor preferences

9.1 Trading and share price returns on the ex date

First evidence in line with investor preferences driving the splits would be if investors rebalanced their portfolios on the divestiture day and if that had a significant impact on share price returns.
To see whether there is increased trading on the ex date, the change in trading volume as compared to an index and a normal period of 100 days is calculated. It reveals significant abnormal trading of 374% for EON and 521% for RWE. Trading increased in a comparable manner when the competitor's subsidiary went public, i.e. at EON on the Innogy ex date and at RWE on the Uniper ex date.[20]

[20] Apart from that, only few events triggered a significant increase in trading, in accordance with the most significant impact on returns described earlier: the decision against a CO_2 levy for RWE, the divestiture announcements for EON and RWE respectively, EON's decision to

Only the Innogy ex date triggered significantly positive abnormal returns for EON (4%) and negative ones for RWE (−7%). So there is evidence that both EON and RWE investors rebalanced their portfolios on both the Uniper and Innogy ex dates. Rebalancing on the Innogy ex date seemed to have been in favour of Innogy and EON and to the detriment of RWE.

This is rather in accordance with a financial driver such as risk contamination, though, as investor preferences would predict only positive abnormal returns on the ex date. If investors wanted to hold only the uncontaminated part because of risk contamination, not because of their individual preferences, they might also wait and trade only on the ex date to avoid transaction costs. This could also explain why there is no significant returns effect on the EON-Uniper ex date: risk separation was not perfect since nuclear stayed with EON.

9.2 Sin stocks, search for yield or falling profits?

Another hint at investor preferences driving the splits would be if investors had expressed support for the splits or interest in certain firm segments.

In December 2016 the number of investors committed to selling off fossil fuel assets had jumped to USD 5.2 trillion in assets under management doubling in just over a year (Carrington 2016). One example is the Norwegian USD 900 billion sovereign wealth fund, the world's biggest after Japan's: in November 2014, the fund, which held 2.1 in EON and 2.2% in RWE stocks, considered a divestment from firms engaged in mining or burning of coal. In May 2015, the fund sent a letter to RWE asking about their plans to exit coal and whether they would consider a split à la EON. In June, Norway's parliament formally endorsed the move to sell off coal investments (Manager Magazin 2014-11-26, 2015-05-06). In 2017, the fund held at least 2.3% of EON and 1.4% of RWE stocks (Norges Bank 2018). What had happened?

As with many investors that committed to divestment policies, the policies left room for exceptions. In the case of the Norwegian fund, their guidelines recommended to divest from companies with more than 30% revenues from coal. RWE does not reach that threshold[21] and even if a company does and but is the process of decreasing its coal activities the fund does not need to divest (Wolff 2018).[22] Probably other investors apply similar guidelines: whereas at least 16 of EON's and 14 of RWE's investors committed to some sort of fossil fuel divestment since 2013, only one of these actually divested from EON and two from RWE. Figure 9.1 shows that the overall share of stocks held by these investors actually increased since 2013.

This does not mean that utilities were not under pressure from investors. In September 2016, Bochum, which held about 1.1% of RWE decided to divest completely. Essen, Düsseldorf, and Dortmund, which were part of the municipal shareholders making up around 23% of RWE holdings, also temporarily considered divesting. This was, however, after RWE's planned split was already long public - so unlikely a driver. And financial reasons played the predominant role: cities were hit hard by falling dividends, which in 2016 were zero at RWE for the first time (Grüne 2016-04-29, Handelsblatt 2017-08, WAZ 2016-09-15).

Many global investors that committed to divest from fossil fuels also mixed ethical and financial arguments: the parliamentary committee recommending Norway's exit from coal assets stated that "investing in coal companies poses both a climate risk and a future economic risk" (Reuters 2015-05-28). This economic risk argument is more akin to the risk contamination hypothesis: if conventional energy becomes unprofitable and excessively risky, a split can offer investors the opportunity to invest in a profitable, uncontaminated business. This argument is distinct, though, from investors' heterogeneous demand for different risk-return profiles or their exclusion of stocks on ethical grounds.

keep the nuclear segment, the leak of the Warth und Klein results for both. The annex contains methodology and detailed results.

[21] Even if excluding revenues from Innogy, lignite and nuclear revenues were responsible for less than 23% in 2016 and 2017.

[22] This policy was changed in April 2019 resulting in an exclusion of RWE.

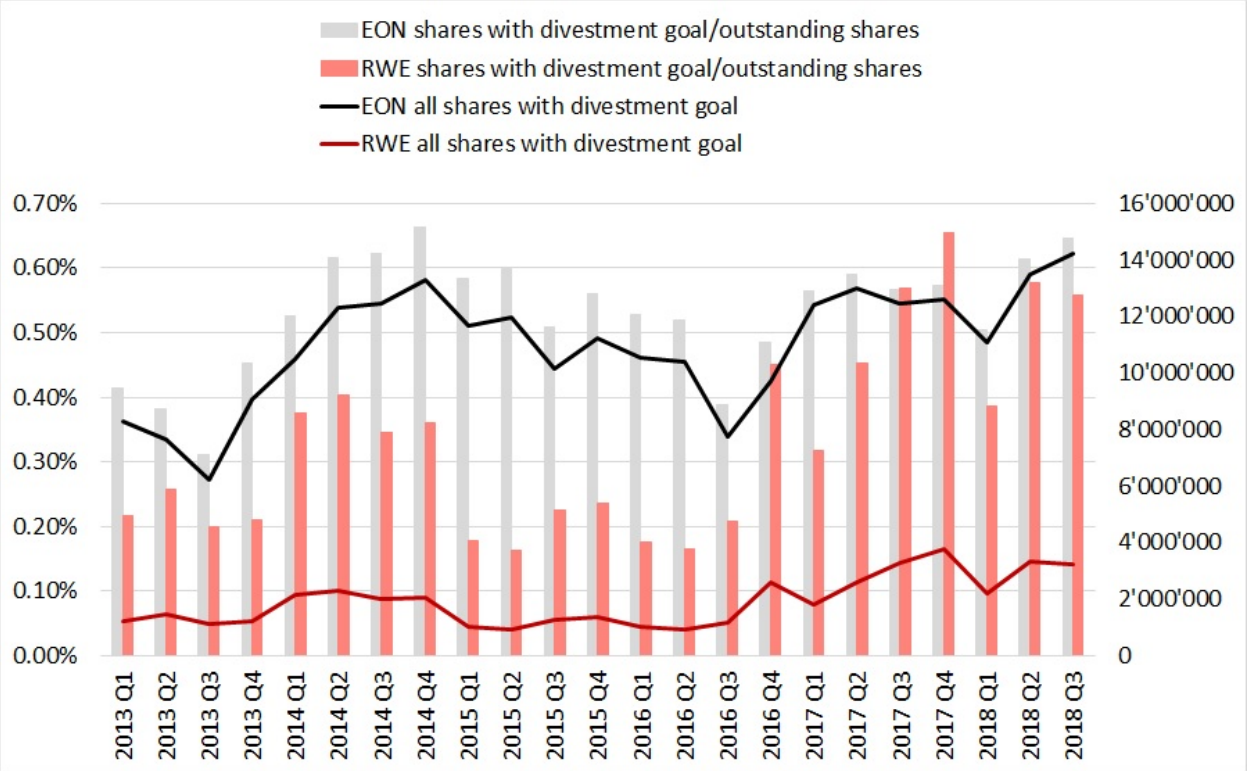


Figure 9.1: Percentages and total shares held by investors committed to divesting from fossil fuels. Source: own calculation based on Thomson Reuters Datastream, Bloomberg and Gofossilfree.org (2018)

9.3 Interview results

Thirteen out of 20 interviewees thought that investors' preferences played a role. A financial journalist thought that "pension funds and other institutionals had high pressure to invest. And grid infrastructure is a pearl in a low interest rate environment." Interviewees also acknowledged, though, that in the energy case it is hard to distinguish a preference for low-risk assets, ethical preferences and the fear of further losses due to risk contamination. "We wanted to get rid of everything with commodity price risk", said one EON staff. "A lot of investors did not want any risk, like municipalities. Mainly because they thought that our past investments had failed." (Interview 6). An equity analyst thought that "there is a lot of interest now in ESG investments, like products with lower CO_2 emissions. Why? I think it is a mixture of risk preferences, return expectations and ethical considerations." (Interview 9)

So while more and more investors wanted to exit fossil fuels and demand for low-risk renewable energy and grid infrastructure assets was apparently high, this could not be traced to one specific reason. It is in line with search for yield, ethical considerations as well as the avoidance of economic loss. Further, since holdings from divestment committed funds did not seem to decrease, it is unclear whether the divestment movement was a concrete factor in the utilities' decisions to split.

10 Conclusion and policy implications

This study has identified four possible types of drivers for divestitures: operations and management, investing, financing and investor preferences. These drivers were tested in the empirical case of the EON and RWE divestitures of 2016. The results of different methods - comparative descriptive statistics, interviews, gray literature and event studies - converged in rejecting drivers related to operations, management and investing. Drivers related to investor preferences could not sufficiently be distinguished from risk contamination.

The analysis supports debt overhang as one driver as EON and RWE accumulated higher liabilities than their peers

due to provisions for nuclear dismantling and storage. There is also strong evidence for risk contamination based on the firms' and subsidiaries' valuations pre- and post-divestiture, a share price event study and interviews. Likely sources of risk contamination were further losses by fossil fuel-fired power plants and the acute risk of unmanageably high nuclear dismantling and especially storage costs linked to the nuclear exit.
In 2015 alone, the year when discussions about provisions for decommissioning nuclear power plants and storing toxic waste intensified, EON's market cap decreased by half and RWE's by 75%. Investors doubted the adequacy of utilities provisions for nuclear related costs, and feared major cost increases while utilities being unlimitedly liable. Even though utilities' nuclear provisions had increased considerably, in 2015 a study estimated a funding gap of up to EUR 40 billion for Germany's nuclear capacity overall.
Utilities restructured to avoid further risk contamination of their healthy assets (renewables and grid infrastructure) by the conventional power generation business (fossil fuel and nuclear plants). There was one major difference between the two utilities' strategies: EON announced to spin off its risky conventional power generation and its trading segment to the new subsidiary Uniper. For RWE, being the second mover, it was already clear that policy makers would not allow nuclear liabilities being spun off. As a result, RWE carved out renewables and grid infrastructure into the new Innogy, turning itself into a conventional generation and trading utility being only financially invested in the growth firm Innogy.
The example of German policy making shows that an ambitious energy transition - the increase in renewables and exit from nuclear - can come at a cost to incumbent utilities. One could argue that severe losses or bankruptcies of main electric utilities are necessary evils in the transition away from a fossil fuel- and nuclear-based power market. However, under certain circumstances there are problems with this approach:

1. In Germany, the utilities' nuclear provisions were not ring-fenced. If utilities had faced further impairments or bankruptcy, tax payers might have had to burdened all costs for dismantling plants and storing nuclear waste. With 22% of electricity produced by nuclear or 20.5 GW of nuclear capacity in 2010, these costs were estimated at between EUR 32 and 77 billion (Warth und Klein 2015).

2. Some authors argue that in the absence of affordable storage solutions, fossil fuel-based power plants are still needed to balance out fluctuating renewable energy. In Germany, these plants were mainly operated by the big incumbent utilities - EON, RWE, Vattenfall and EnBW.

3. In addition to power generation, the big German utilities also played a main role in electricity trading, operation of distribution grids and provision of customer services. A bankruptcy might have thus endangered not only security of supply in power generation but in the whole energy value chain.

In this market environment, risking utilities' bankruptcy might have destroyed more value than it created. For this reason policy makers were caught in between a 'polluter pays' and a 'too big to fail' attitude, leading to indecisive, contradictory and possibly too lenient policies. Three measures might have altered the market environment ex-ante such as to avoid the three problems described above:

1. The early set-up of a well-endowed, ring-fenced and state-run fund for nuclear provisions following the example of countries like France and Switzerland. German utilities had their golden times in the late 2000s. This would have been the time to skim off some profits to secure appropriate funding for nuclear dismantling and storage.

2. Even though heavily debated and possibly not necessary in Germany at the time, a well-designed and transparent capacity market might have its merits depending on the existing power plant fleet and structure of the electricity market. As Weber (2017) notes, "prices based on volatile marginal costs and a long-term capital lock-up are not a good basis for substantial investment. In most deregulated electricity markets in the US and Europe capacity mechanisms exist, which together with energy trading ensure the security of supply."

3. A less oligopolistic power market structure helps against the moral hazard of 'too big to fail'. [23] Germany's oligopolistic market structure is partly the effect of natural monopoly tendencies and partly caused by the governmentally encouraged mergers in the 1990s. While oligopolies especially in grid infrastructure cannot be avoided, moves towards further market concentration like the recent EON-RWE asset swap should be viewed critical. The benefits of scale stand against not only potential price increases for consumers but also the exposure of the power market to concentration risk and the need for bail-outs by tax payers.

Further research might look into how other sectors or sub-sectors can benefit from past experiences like the German case, in which way they differ and what might be policy tools most appropriate for each one. An interesting case would be the coal exit, Germany's next big step in the energy transition. With the coal commission just having adopted its recommendations to exit hard coal- and lignite-based power by 2038, parallels and differences to the nuclear exit will be interesting to explore. Another interesting sector is mobility: applying these lessons to the transformation of the market for combustion engines could possibly save costs for tax payers and industry alike.

[23] From this point of view, the fixed feed-in tariff was a clever move to bring in citizens, local business and financial investors as new investor classes in addition to the incumbent utilities. Similar developments emerged in countries with different policy regimes as well, for example in California as analysed in Vargas and Chesney (2018).

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Interview 6: EON staff, 2018-06-21.

Interview 7: RWE staff, 2018-06-21.

Interview 8: EON staff, 2018-06-22.

Interview 9: Equity analyst, 2018-06-22.

Interview 10: EON staff, 2018-06-23.

Interview 11: Financial journalist, 2018-06-26.

Interview 12: Academic, 2018-06-28.

Interview 13: Financial journalist, 2018-06-28.

Interview 14: Equity analyst, 2018-07-06.

Interview 15: RWE management, 2018-07-06.

Interview 16: RWE management, 2018-09-27.

Interview 17: EON management, 2018-10-29.

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13 Annex

13.1 EON's and RWE's generation portfolios and geographical origin of revenues

See figure 13.1 and 13.2.

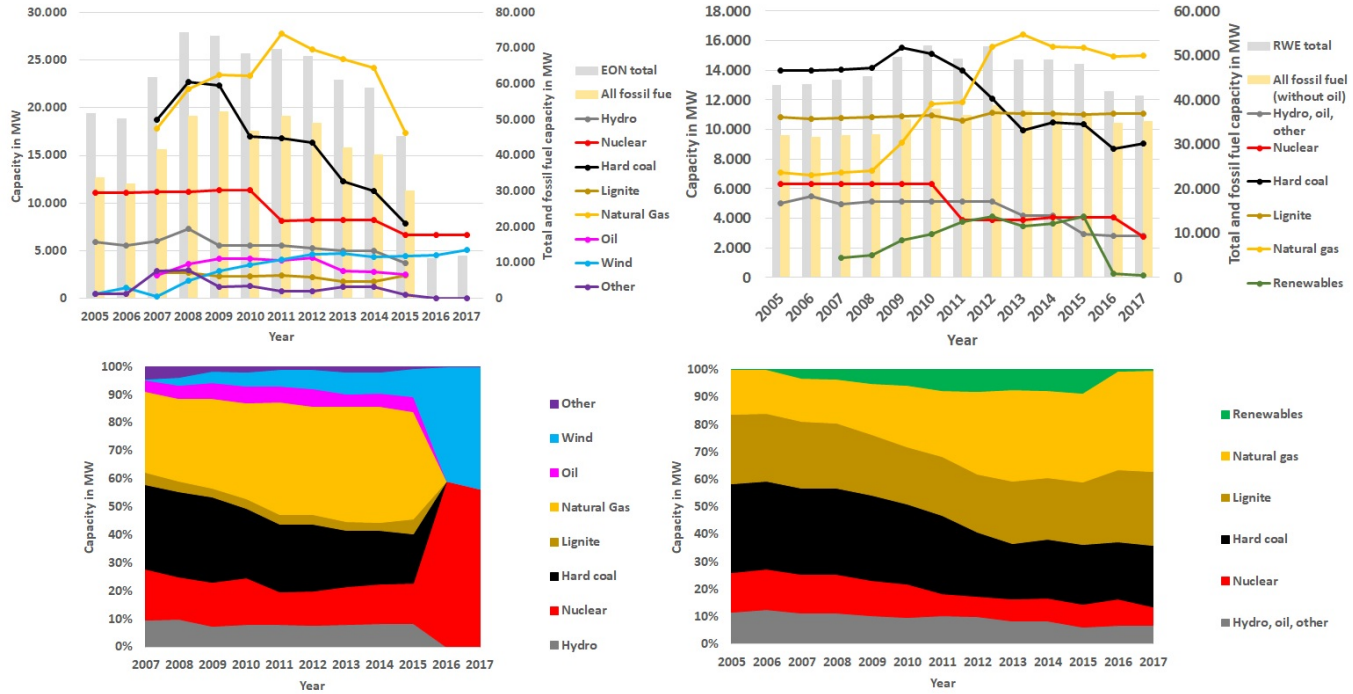


Figure 13.1: Generation portfolios at EON (left) and RWE (right). Source: Own calculation based on EON and RWE annual reports.

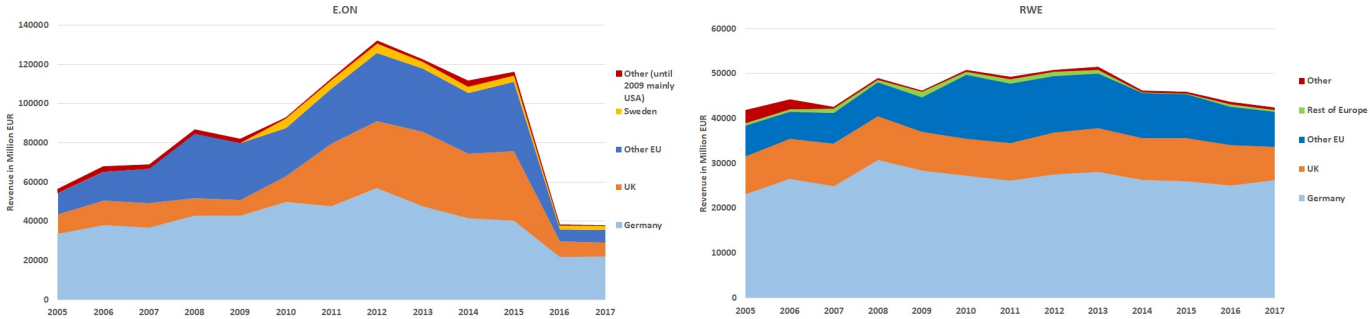


Figure 13.2: Origin of revenues by country at EON (left) and RWE (right). Source: Own calculation based on EON and RWE annual reports.

13.2 The Stoxx Europe 600 Utilities control groups

13.2.1 Method

The method for establishing the control groups is as follows:

- **All Stoxx 600 Europe Utilities without EON, RWE, Uniper and Innogy**. The Stoxx 600 Europe index has a fixed number of 600 components representing large, mid and small capitalization companies among 17 European countries covering approximately 90% of the free-float market capitalization of the European stock market. The countries that make up the index are Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Switzerland, Sweden and the United Kingdom. The Stoxx 600 Europe Utilities index contains the utilities thereof. As of November 2018, it had 28 components, which are listed in the annex. Excluding EON, RWE, Uniper and Innogy, the control groups results in 24 firms.

- **Only merchant or diversified electric utilities without majority shareholder**. This sub control group is constructed in order to avoid any biases arising from utilities that are very different from EON and RWE in terms of business model, products or shareholders. The sub control group is received by creating three sub control groups and then taking the overlap of those.

  The first sub control group contains only Stoxx Europe utilities whose returns are not almost entirely governmentally regulated. The information is obtained from the utilities' annual reports from 2014 to 2017, the years that are most relevant for this research. Examples for entirely regulated utilities, thus not part of the sub group, are the Spanish gas grid operator Enagas or National Grid, Great Britain's electricity transmission network. The reason for excluding them is that utilities with regulated returns are less exposed to commodity and policy risk and might be able to take up more debt (Interview 12) also reflected in different credit rating methodologies (Moodys 2017). 5 out of the 24 non-German utilities were almost entirely regulated.

  The second sub group is created by excluding utilities not mainly active in electricity or gas, which are EON's and RWE's main products. Annual reports are used to identify 6 utilities out of 24, which are mainly active in the waste and water sectors. These markets are likely governed by different pressures than the ones our case study utilities operate in.

  The third sub group excludes any utility that had an influential shareholder at some point between 2014 and 2017. Influential shareholders are defined as those holding veto power or own golden shares.[24] Data for this is taken from Thomson Reuters Datastream. EDF or Fortum are examples of utilities dominated by the French and Finnish state respectively. 6 utilities fell in that category. They might experience certain benefits or also pressures from their dominant shareholder, differentiating them from utilities with diversified shareholder bases (Maug 2002). The overlap of these three different sub groups creates a sub control group that consists of only 9 utilities.

13.2.2 List of Stoxx Europe 600 Utilities components used for control group

See table 3.

13.3 Capital expenditure indicators

13.3.1 Capital expenditure correlations

See table 4.

13.3.2 Capital expenditure over operating cash flows

See table 5.

[24] A golden share gives its owner the right to outvote all other shares in certain specified circumstances.

	Country	Mainly regulated business	Products not mainly electricity or gas related	Any majority shareholder 2014-2017
A2A SpA	Italy			
Centrica PLC	Great Britain			
EON	Germany			
EDF	France			X
EDP	Portugal			
Enagas	Spain	X		
Endesa	Spain			X
Enel	Italy			
Engie/GDF Suez	France			X
Fortum	Finland			X
Iberdrola	Spain			
Innogy	Germany			
Italgas/Snam	Italy	X		
National Grid	Great Britain	X		
Naturgy Energy Group	Spain			
Orsted/Dong	Denmark			X
Pennon Group	Great Britain		X	
Red Electrica Corporation	Spain	X		
Rubis	France		X	
RWE	Germany			
Scottish and Southern Energy	Great Britain			
Severn Trent	Great Britain		X	
Suez Environnement	France		X	
Terna	Italy	X		
Uniper	Germany			
United Utilities Group	Great Britain	X	X	
Veolia Environnement	France		X	

Table 3: List of Stoxx Europe 600 Utilities components. Source: https://www.stoxx.com/index-details?symbol=SX6p, accessed on November 10, 2018.

EON capex with total capex	Generation	67.98%
	Renewables	26.84%
	Germany networks and customer solutions	77.62%
EON capex with segment operating cash flows	Generation	98.75%
	Renewables	-38.52%
	Germany networks and customer solutions	23.61%
RWE capex with total capex	Germany power generation	-0.30%
	Conventional power generation	98.41%
	Renewables	15.15%
	Germany sales and distribution networks	60.21%
RWE capex with segment cash flows	Germany power generation	25.89%
	Conventional power generation	-22.06%
	Renewables	59.42%
	Germany sales and distribution networks	13.22%

Table 4: Correlations of segment capital expenditure data with total capital expenditure and with segment operating cash flows. Source: own calculation based on EON and RWE annual reports. Years are as plotted in the graph above.

		2010	2011	2012	2013	2014	2015	2016	2017	Average
EON capex over segment operating cash flows	E.ON SE Group	78.07%	83.01%	68.67%	99.56%	56.36%	59.30%	79.74%	-148.01%	74.16%
	Generation	66.17%	64.71%	56.88%	57.54%	48.73%	37.53%			55.26%
	Renewables	91.97%	80.96%	151.78%	67.90%	105.25%	87.67%			97.59%
	Germany networks and customer solutions	62.56%	54.43%	37.31%	30.27%	40.25%	84.21%	47.40%	28.07%	51.50%
RWE capex over segment cash flows	RWE Group	115.98%	115.30%	115.61%	78.09%	58.41%	86.79%	86.18%		84.72%
	Germany power generation	37.29%	41.82%	68.37%						
	Conventional power generation			131.47%	121.21%	47.61%	37.86%	24.78%		84.54%
	Renewables	479.69%	585.11%		178.70%	488.51%	774.07%			480.43%
	Germany sales and distribution networks	83.39%	121.94%	115.45%	53.73%	48.26%	65.66%			70.78%

Table 5: Capital expenditure in EON's and RWE's main segments over operating cash flows in the same segments. Average for EON 2010-2015, for RWE 2012-2015. Source: own calculation based on EON and RWE annual reports.

13.4 EBIT(DA) and free cash flow of main segments

See table 13.3.

13.5 Leverage and liquidity indicators

See figure 13.4.

13.6 Calculation of market capitalisation of parents and subsidiaries pre- and post divestiture

0 always refers to the divestiture day, i.e. 12/09/2016 for the EON-Uniper spinoff and 07/10/2016 for the IPO of Innogy. −1 is the trading day prior to that.

$$\text{Post-split Uniper} = \text{Uniper}_0$$

$$\text{Pre-split EON} = \text{EON}_{-1}$$

$$\text{Post-split EON cum Uniper} = \text{EON}_0 + \text{Uniper}_0$$

$$\text{Pre-split EON ex Uniper} = \text{EON}_{-1} - \text{Uniper}_0$$

$$\text{Post-split EON ex Uniper} = \text{EON}_0$$

$$\text{Post-split Innogy} = \text{Innogy}_0$$

$$\text{Pre-split RWE} = \text{RWE}_{-1}$$

$$\text{Post-split RWE cum Innogy} = \text{RWE}_0 + (1 - 0.768) \cdot \text{Innogy}_0$$

$$\text{Pre-split RWE ex Innogy} = \text{RWE}_{-1} - \text{Innogy}_0$$

$$\text{Post-split RWE ex Innogy} = \text{RWE}_0 - 0.768 \cdot \text{Innogy}_0$$

13.7 Enterprise value over EBITDA

See figure 13.5.

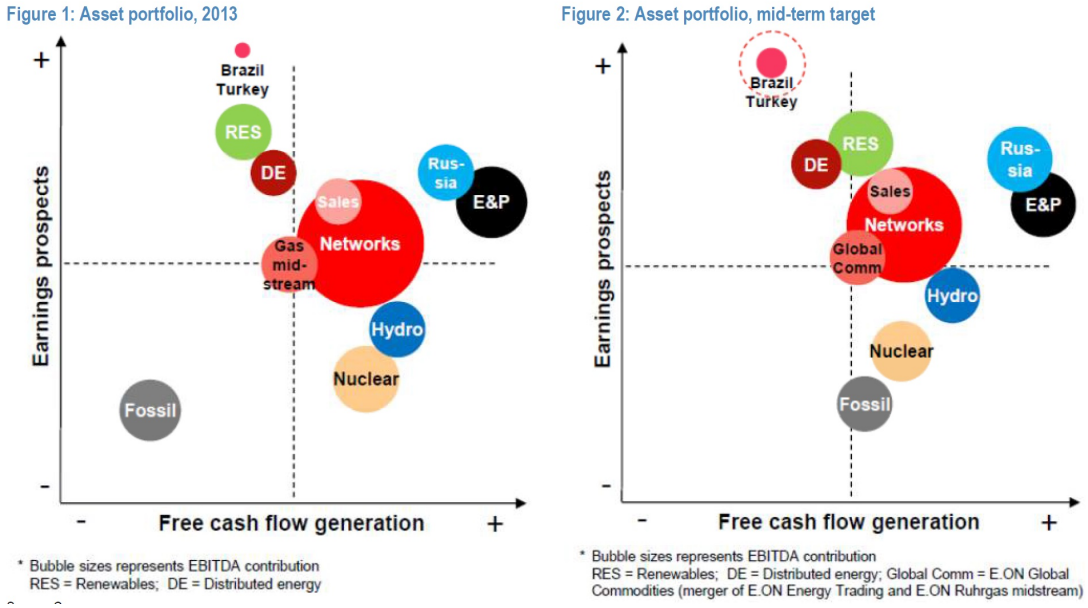
13.8 Event studies

13.8.1 Share price event study

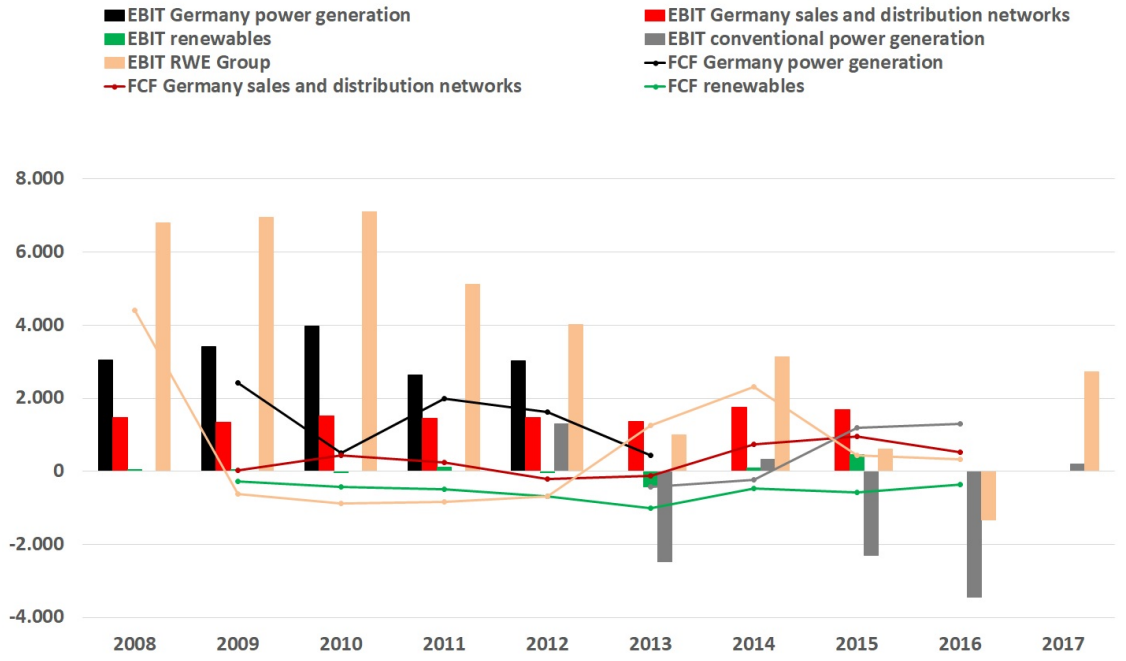
Estimation strategy Following MacKinlay (1997) and Kothari and Warner (2007), the market model is defined as follows: $R_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}}$
$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \epsilon_{i,t}$
$E(\epsilon_{i,t}) = 0$
$\text{var}(\epsilon_{i,t}) = \sigma^2_{\epsilon_t}$
where $P_{i,t}$ are the period-t share prices and $R_{i,t}$ and $R_{m,t}$ the period-t returns of firm i (EON or RWE) and the market portfolio, respectively. ϵ_i, t is the the zero mean disturbance term. α_i, β_i and $\sigma^2_{\epsilon_t}$ are the parameters of the market model. Following the literature in using a broad based stock index, the Stoxx Europe 600 index as of November 2018 is used for the market portfolio.
The predicted return for a firm for a day in the event period is thus given by the estimation of this market model during a normal period defined as $N = 100$, i.e. day -101 to -1 prior to the event day:
$\hat{R}_{i,t} = \hat{\alpha}_i + \hat{\beta}_i R_{m,t}$

Then the abnormal returns of each firm i = EON, RWE on the event day, $t = 0$, is calculated:
$r_{i,t} = R_{i,t} - \hat{R}_{i,t}$
The relatively short normal and event periods are justified by the fast succession of events especially in 2015 and 2016, but results are largely robust to longer periods of up to 200 and 40 days respectively.
If returns are normally, identically and independently distributed, then
$\frac{r_{i,t}}{\hat{s}(r_i)}$
has a t-distribution, with $\hat{s}(r_i) = \frac{1}{N-1}\sum_{t=-N-1}^{t=-1}(r_{i,t} - \bar{r}_i)^2$ being the standard deviation of the residuals over the normal period prior to the event day.

Regression results See table 6.

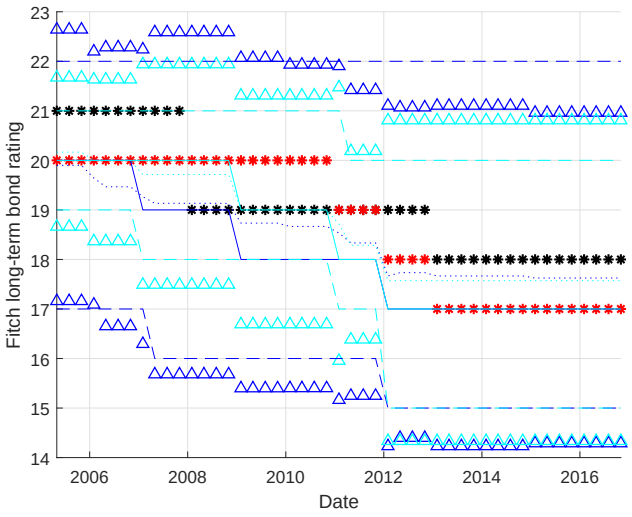


(a) EON EBITDA contributions, free cash flow generation and earning prospects. Source: JP Morgan 2013 from EON.

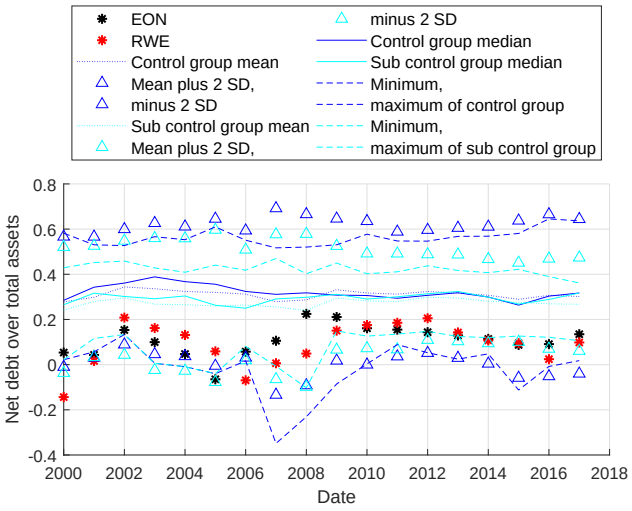


(b) RWE EBIT and free cash flows in the main segments in million Euros. In contrast to adjusted numbers that exclude "non-operational effects", e.g. impairments, this is an estimation of the unadjusted EBIT = adjusted EBITDA - (operating depreciation + amortisation) - impairments. Source: own calculation and illustration, data from RWE annual reports.

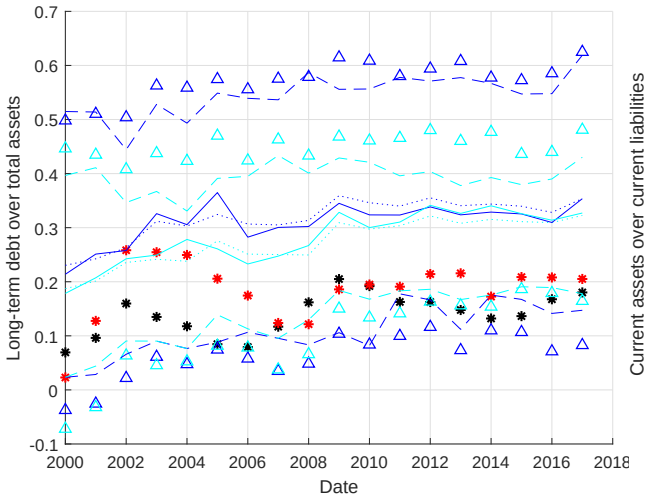
Figure 13.3: Illustrations of value creation and potential by segments at EON and RWE.



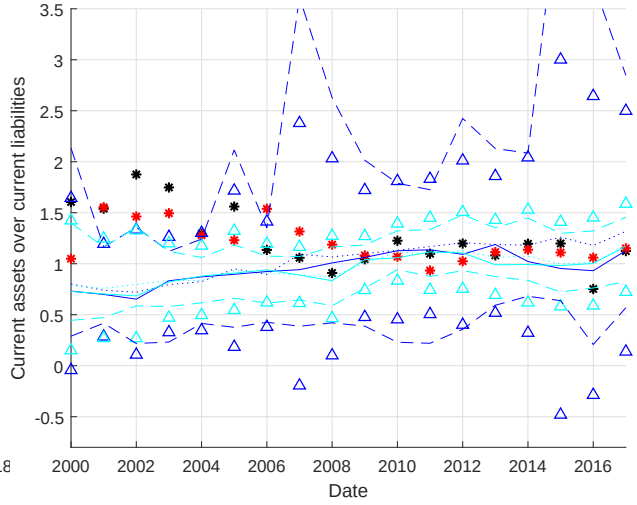
(a) Long-term bond rating as provided by Fitch. AAA = 24, DDD = 1.



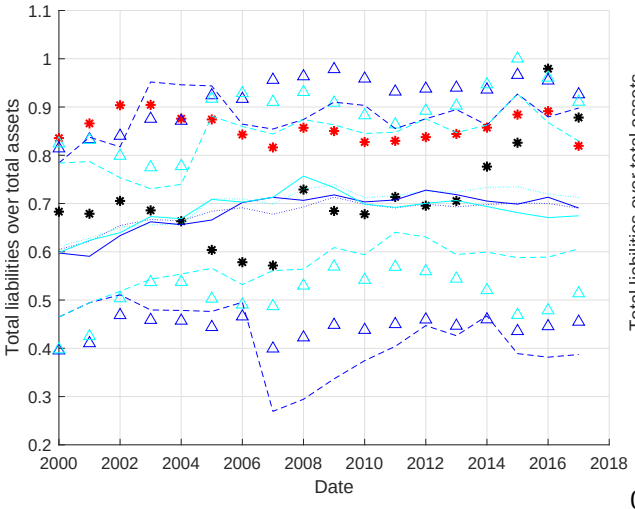
(b) Net debt over total assets. Net debt is total debt minus cash and short-term investments.



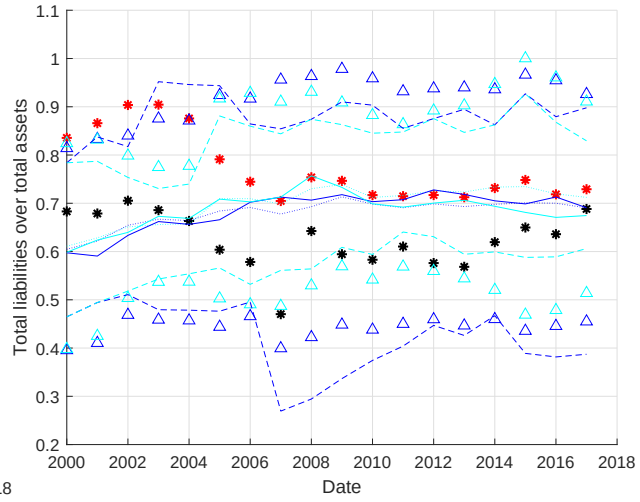
(c) Long-term debt over total assets.



(d) Liquidity ratio: current assets over current liabilities.



(e) Total liabilities over total assets.



(f) Total liabilities and, for EON and RWE, total liabilities less provisions for nuclear dismantling and storage over total assets.

Figure 13.4: Leverage and liquidity indicators. Source: own calculation and illustration, data by Thomson Reuters Datastream.

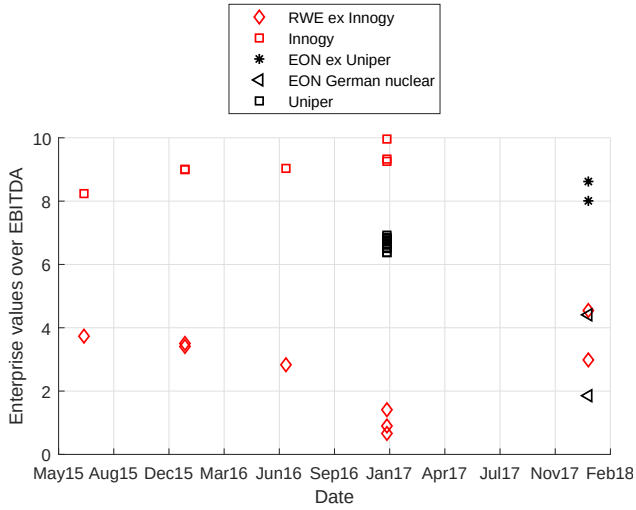


Figure 13.5: JP Morgan's estimates for enterprise value over EBITDA based on reports between May 2014 and June 2017. Source: own illustration based on J.P. Morgan Cazenove (2014-2017).

Table 6: Regression results for share price event study. Two-sided t-test, * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day. Type refers to the type of event: RE = renewable energy, N = nuclear policy, C = climate policy, D = divestiture related.

Event date t	Description	Source	Type	Exp. effect	α_{EON}	β_{EON}	R^2_{EON}	$\hat{s}(r_{\text{EON}})$	$r_{\text{EON},t}$	α_{RWE}	β_{RWE}	R^2_{RWE}	$\hat{s}(r_{\text{RWE}})$	$r_{\text{RWE},t}$
28-Jan-2013	Minister for the Environment, Altmaier, publishes proposal to cap renewable energy subsidy cost.	Handelsblatt (2013-01)	RE	+	-0.004	0.676	10.01%	0.013	-0.013	-0.003	0.770	18.65%	0.011	-0.004
9-Nov-2013	Agreement in CDU-SPD coalition talks on measures to cap renewable energy support costs.	Handelsblatt (2013-11)	RE	+	0.000	0.676	10.39%	0.014	0	0.000	0.605	4.69%	0.019	-0.002
21-Jan-2014	Measures to cap renewable energy costs are further specified by Ministry of Economic Affairs and Energy.	Gabriel (2014)	RE	+	0.001	0.798	10.45%	0.013	-0.003	0.002	0.793	5.81%	0.018	-0.001
5-May-2014	Handelsblatt reports on speech draft by environmental ministry executive saying that nuclear provisions will be examined soon.	Stratmann (2014)	N	-	-0.001	0.834	31.59%	0.009	-0.003	-0.000	0.835	18.41%	0.014	-0.004
11-May-2014	Utilities suggest government-run nuclear fund that takes over all operationial, dismantling and storage related tasks in exhange for dropping various lawsuits against the government worth around Euros 15 billion.	Spiegel (2014), Dohmen and Hawranek (2014)	N	+	0.000	0.882	32.02%	0.010	0	0.000	0.879	18.64%	0.014	-0.011
27-Jun-2014	Bundestag decides on renewable energy law reform (EEG 2014) capping renewables subsidy cost.	BMWi (2014-06)	RE	+	0.001	0.863	24.55%	0.010	0	0.001	0.874	16.04%	0.013	0.013

Table 6: Regression results for share price event study. Two-sided t-test, * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day. Type refers to the type of event: RE = renewable energy, N = nuclear policy, C = climate policy, D = divestiture related.

Event date t	Description	Source	Type	Exp. effect	α_{EON}	β_{EON}	R^2_{EON}	$\hat{s}(r_{\text{EON}})$	$r_{\text{EON},t}$	α_{RWE}	β_{RWE}	R^2_{RWE}	$\hat{s}(r_{\text{RWE}})$	$r_{\text{RWE},t}$
23-Nov-2014	Minister in charge of energy, Gabriel, presents idea for CO2 reduction contribution by coal power plants.	Handelsblatt (2014-11)	C	-	-0.001	1.223	57.72%	0.010	0.002	-0.001	1.341	52.35%	0.012	0.003
30-Nov-2014	E.ON announces to split off Uniper.	Drozdiak (2014)	D	+	0.000	1.237	54.68%	0.010	0.041***	-0.001	1.352	49.03%	0.012	0.014
17-Dec-2014	Süddeutsche Zeitung learns that state-run fund with 17 bn is planned according to ministries. Fund should solely secure funds but not take any operational or other liabilities.	Handelsblatt (2014-12)	N	-	0.000	1.182	51.86%	0.011	0.012	-0.001	1.336	51.63%	0.013	0.013
20-Mar-2015	Report written by consultancy Becker Büttner Held for Ministry of Economic Affairs concludes according to Handelsblatt that provisions are only safe if moved into external fund.	Handelsblatt (2015)	N	-	-0.001	0.989	36.62%	0.013	0.015	-0.003	1.030	29.98%	0.016	-0.002
21-Mar-2015	Secretary of State for Energy, Baake, publishes paper on how coal power plants should contribute to climate policy via a proposed CO2 levy.	Frese (2015)	C	-	-0.001	0.980	35.47%	0.013	-0.005	-0.003	1.016	28.94%	0.016	-0.007

Table 6: Regression results for share price event study. Two-sided t-test, * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day. Type refers to the type of event: RE = renewable energy, N = nuclear policy, C = climate policy, D = divestiture related.

Event date t	Description	Source	Type	Exp. effect	α_{EON}	β_{EON}	R^2_{EON}	$\hat{s}(r_{\text{EON}})$	$r_{\text{EON},t}$	α_{RWE}	β_{RWE}	R^2_{RWE}	$\hat{s}(r_{\text{RWE}})$	$r_{\text{RWE},t}$
11-Jun-2015	Tagesschau reports on letter by CDU against the planned CO2 levy.	Mayer-Rüth (2015)	C	+	-0.001	0.871	27.20%	0.012	-0.016	-0.002	0.992	27.52%	0.014	-0.011
24-Jun-2015	Tagesschau reports on the failure of an agreement on a CO2 levy and instead the granting of compensation payments to lignite power plant operators.	Tagesschau (2015)	C	+	-0.001	0.911	29.85%	0.012	-0.001	-0.003	1.053	34.55%	0.013	0.025***
2-Jul-2015	Government publishes compromise on CO2 levy.	Flauger (2015-07)	C	+	-0.001	0.909	32.59%	0.012	0.018	-0.002	0.970	33.59%	0.013	0.058***
28-Jul-2015	Leak of paper by Professors Irrek and Vorfeld casts doubt on security of nuclear provisions.	Süddeutsche Zeitung (2015)	N	-	-0.001	0.895	42.58%	0.011	-0.004	-0.002	0.948	36.07%	0.013	-0.006
9-Sep-2015	EON announces to keep nuclear segment.	Vasagar (2015)	D/N	-	-0.003	0.861	55.56%	0.011	-0.024***	-0.005	0.919	38.77%	0.017	-0.021
10-Sep-2015	Supervisory board agrees to keep nuclear with EON.	Bayernkurier (2015)	D	-	-0.003	0.845	53.93%	0.011	-0.058***	-0.005	0.905	38.04%	0.017	-0.021
11-Sep-2015	Handelsblatt first writes about Warth and Klein report, which will examine whether discount rate used for nuclear provisions is too high.	Flauger (2015-09)	N	-	-0.003	0.877	50.12%	0.013	-0.029***	-0.005	0.915	38.36%	0.017	-0.023

Table 6: Regression results for share price event study. Two-sided t-test, * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day. Type refers to the type of event: RE = renewable energy, N = nuclear policy, C = climate policy, D = divestiture related.

Event date t	Description	Source	Type	Exp. effect	α_{EON}	β_{EON}	R^2_{EON}	$\hat{s}(r_{\text{EON}})$	$r_{\text{EON},t}$	α_{RWE}	β_{RWE}	R^2_{RWE}	$\hat{s}(r_{\text{RWE}})$	$r_{\text{RWE},t}$
15-Sep-2015	Spiegel leaks information on draft Warth and Klein study conclusions allegedly identifying a EUR 30bn nuclear funding gap.	Dohmen (2015)	N	-	-0.004	0.879	49.67%	0.013	-0.066***	-0.005	0.934	39.59%	0.017	-0.035***
17-Sep-2015	After pressure from all four utilities, minister in charge of energy, Gabriel, denies Warth and Klein conclusions. RWE is in talks for capital injection with Abu Dhabi investment firm.	Dohmen and Schießl (2015-09-19)	N	+	-0.005	0.802	34.43%	0.016	0.082***	-0.006	0.893	34.11%	0.018	0.099***
5-Oct-2015	Duin, economy minister of utilities' home state North-Rhine Westphalia, demands to cap nuclear liabilities in order not to endanger utilities.	Welt (2015)	N	+	-0.004	0.879	32.23%	0.019	0.016	-0.006	0.917	24.65%	0.024	0.053***
8-Oct-2015	Publication of stress test (Warth and Klein) report with main conclusion that firms set aside enough nuclear decommissioning funds.	Copley and Eckert (2015)	N	+	-0.003	0.904	32.83%	0.020	0.005	-0.005	0.980	25.87%	0.025	0.005
1-Dec-2015	RWE announces to split off Innogy.	Terium and Günther (2015)	D	+	-0.003	0.938	27.53%	0.022	0.013	-0.005	1.134	21.38%	0.032	0.165***

Table 6: Regression results for share price event study. Two-sided t-test, * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day. Type refers to the type of event: RE = renewable energy, N = nuclear policy, C = climate policy, D = divestiture related.

Event date t	Description	Source	Type	Exp. effect	α_{EON}	β_{EON}	R^2_{EON}	$\hat{s}(r_{\text{EON}})$	$r_{\text{EON},t}$	α_{RWE}	β_{RWE}	R^2_{RWE}	$\hat{s}(r_{\text{RWE}})$	$r_{\text{RWE},t}$
27-Apr-2016	Commission unveils plans for utilities to pay EUR 23.3bn towards the cost of storing nuclear waste in exchange for a cap on storage liabilities. It is expected that the government follows the recommendation.	Financial Times (2016)	N	+/-	0.002	1.245	49.14%	0.018	0.031*	0.002	1.075	27.02%	0.026	0.053***
12-Sep-2016	EON's subsidiary Uniper is first listed in a spin-off to existing shareholders.	Steitz and Schütze (2016)	D	+/-	-0.001	1.121	48.27%	0.015	-0.014	0.002	1.308	38.10%	0.022	-0.007
7-Oct-2016	RWE's subsidiary Innogy is first listed in an IPO including an equity increase.	Steitz (2016-10)	D	+/-	-0.002	1.127	51.63%	0.014	0.037***	0.002	1.327	48.53%	0.018	-0.07***

Addition to abnormal returns	EON			RWE		
	*	**	***	*	**	***
0	8.57%	5.43%	3.43%	7.14%	5.71%	3.43%
0.02	38.57%	29.43%	13.14%	33.14%	19.43%	6.57%
0.05	95.43%	92.86%	80.29%	83.14%	76.57%	62.00%

Table 7: Brown Warner simulation for share price event study. Percentage of significant regression results of 350 two-sided t-tests for event dates drawn randomly from t = [01-Jan-2013; 07-Oct-2016], * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day.

Brown Warner simulation See table 7.

13.8.2 Trading volume event study

Estimation strategy Following the estimation strategy for the share price return market model, the market model for the trading volume data is defined as follows:

$V_{i,t} = \frac{T_{i,t} - T_{i,t-1}}{T_{i,t-1}}$

$V_{i,t} = \alpha_i + \beta_i V_{m,t} + \epsilon_{i,t}$

$E(\epsilon_{i,t}) = 0$

$\text{var}(\epsilon_{i,t}) = \sigma^2_{\epsilon_t}$

where $T_{i,t}$ are the period-t numbers of stocks traded and $V_{i,t}$ and $V_{m,t}$ the period-t changes of firm i's (EON's or RWE's) and the market portfolio's trading volume, respectively. ϵ_i, t is the the zero mean disturbance term. α_i, β_i and $\sigma^2_{\epsilon_t}$ are the parameters of the market model. In absence of a broad based index for stock trading volume data, the sum of the trades of all Stoxx 600 Europe Utilities components (see 13.2.2) is used as the market portfolio.

The predicted change in trading volume for a firm for a day in the event period is thus given by the estimation of this market model during a normal period defined as $N = 100$, i.e. day -101 to -1 prior to the event day:

$\hat{V}_{i,t} = \hat{\alpha}_i + \hat{\beta}_i V_{m,t}$

Then the abnormal change in trading volume of each firm i = EON, RWE on the event day, $t = 0$, is calculated:

$v_{i,t} = V_{i,t} - \hat{V}_{i,t}$

If returns are normally, identically and independently distributed, then

$\frac{v_{i,t}}{\hat{s}(v_i)}$

has a t-distribution, with $\hat{s}(v_i) = \frac{1}{N-1} \sum_{t=-N-1}^{t=-1} (v_{i,t} - \bar{v}_i)^2$ being the standard deviation of the residuals over the normal period prior to the event day.

Regression results See table 8.

Table 8: Regression results for trading volume event study. Two-sided t-test, * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day. Type refers to the type of event: RE = renewable energy, N = nuclear policy, C = climate policy, D = divestiture related.

Event date t	Description	Source	Type	Exp. effect	α_{EON}	β_{EON}	R^2_{EON}	$\hat{s}(\upsilon_{\text{EON}})$	$\upsilon_{\text{EON},t}$	α_{RWE}	β_{RWE}	R^2_{RWE}	$\hat{s}(\upsilon_{\text{RWE}})$	$\upsilon_{\text{RWE},t}$
28-Jan-2013	Minister for the Environment, Altmaier, publishes proposal to cap renewable energy subsidy cost.	Handelsblatt (2013-01)	RE	+	0.17	1.41	0.11	1.10	-0.5	0.24	1.39	0.12	1.01	-0.378
9-Nov-2013	Agreement in CDU-SPD coalition talks on measures to cap renewable energy support costs.	Handelsblatt (2013-11)	RE	+	0.15	0.37	0.03	0.76	0.611	0.26	-0.05	0.00	1.04	-0.346
21-Jan-2014	Measures to cap renewable energy costs are further specified by Ministry of Economic Affairs and Energy.	Gabriel (2014)	RE	+	0.20	0.43	0.03	0.87	-0.723	0.27	0.50	0.02	1.18	-1.207
5-May-2014	Handelsblatt reports on speech draft by environmental ministry executive saying that nuclear provisions will be examined soon.	Stratmann (2014)	N	-	0.15	0.49	0.03	0.74	-0.545	0.27	0.19	0.00	1.06	0.576
11-May-2014	Utilities suggest government-run nuclear fund that takes over all operationial, dismantling and storage related tasks in exhange for dropping various lawsuits against the government worth around Euros 15 billion.	Spiegel (2014), Dohmen and Hawranek (2014)	N	+	0.14	0.50	0.03	0.75	0.435	0.30	0.12	0.00	1.07	-0.711
27-Jun-2014	Bundestag decides on renewable energy law reform (EEG 2014) capping renewables subsidy cost.	BMWi (2014-06)	RE	+	0.23	0.99	0.08	0.95	-0.669	0.33	0.92	0.04	1.22	0.003

Table 8: Regression results for trading volume event study. Two-sided t-test, * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day. Type refers to the type of event: RE = renewable energy, N = nuclear policy, C = climate policy, D = divestiture related.

Event date t	Description	Source	Type	Exp. effect	α_{EON}	β_{EON}	R^2_{EON}	$\hat{s}(v_{\text{EON}})$	$v_{\text{EON},t}$	α_{RWE}	β_{RWE}	R^2_{RWE}	$\hat{s}(v_{\text{RWE}})$	$v_{\text{RWE},t}$
23-Nov-2014	Minister in charge of energy, Gabriel, presents idea for CO2 reduction contribution by coal power plants.	Handelsblatt (2014-11)	C	-	0.38	1.01	0.02	1.93	-0.345	0.57	1.89	0.06	2.19	-0.312
30-Nov-2014	E.ON announces to split off Uniper.	Drozdiak (2014)	D	+	0.38	1.22	0.03	1.93	12.353***	0.61	2.04	0.07	2.21	-0.173
17-Dec-2014	Süddeutsche Zeitung learns that state-run fund with 17 bn is planned according to ministries. Fund should solely secure funds but not take any operational or other liabilities.	Handelsblatt (2014-12)	N	-	0.49	0.82	0.01	2.30	0.018	0.62	1.81	0.05	2.24	-0.603
20-Mar-2015	Report written by consultancy Becker Büttner Held for Ministry of Economic Affairs concludes according to Handelsblatt that provisions are only safe if moved into external fund.	Handelsblatt (2015)	N	-	0.37	0.55	0.01	1.68	0.151	0.41	0.64	0.01	1.41	-0.5
21-Mar-2015	Secretary of State for Energy, Baake, publishes paper on how coal power plants should contribute to climate policy via a proposed CO2 levy.	Frese (2015)	C	-	0.38	0.54	0.01	1.68	-0.329	0.42	0.60	0.01	1.40	0.501

Table 8: Regression results for trading volume event study. Two-sided t-test, * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day. Type refers to the type of event: RE = renewable energy, N = nuclear policy, C = climate policy, D = divestiture related.

Event date t	Description	Source	Type	Exp. effect	α_{EON}	β_{EON}	R^2_{EON}	$\hat{s}(v_{\text{EON}})$	$v_{\text{EON},t}$	α_{RWE}	β_{RWE}	R^2_{RWE}	$\hat{s}(v_{\text{RWE}})$	$v_{\text{RWE},t}$
11-Jun-2015	Tagesschau reports on letter by CDU against the planned CO2 levy.	Mayer-Rüth (2015)	C	+	0.21	0.94	0.06	0.99	0.912	0.34	0.96	0.05	1.19	-0.878
24-Jun-2015	Tagesschau reports on the failure of an agreement on a CO2 levy and instead the granting of compensation payments to lignite power plant operators.	Tagesschau (2015)	C	+	0.21	0.91	0.06	0.99	0.949	0.35	1.08	0.05	1.22	2.568***
2-Jul-2015	Government publishes compromise on CO2 levy.	Flauger (2015-07)	C	+	0.21	0.79	0.05	0.93	0.296	0.36	0.94	0.04	1.23	5.855***
28-Jul-2015	Leak of paper by Professors Irrek and Vorfeld casts doubt on security of nuclear provisions.	Süddeutsche Zeitung (2015)	N	-	0.29	0.93	0.05	1.07	-0.569	0.40	0.60	0.01	1.36	-0.891
9-Sep-2015	EON announces to keep nuclear segment.	Vasagar (2015)	D/N	-	0.24	1.01	0.09	0.97	0.342	0.35	0.23	0.00	1.21	-0.579
10-Sep-2015	Supervisory board agrees to keep nuclear with EON.	Bayernkurier (2015)	D	-	0.24	1.04	0.09	0.97	5.944***	0.36	0.20	0.00	1.21	0.83
11-Sep-2015	Handelsblatt first writes about Warth and Klein report, which will examine whether discount rate used for nuclear provisions is too high.	Flauger (2015-09)	N	-	0.30	1.13	0.08	1.13	-0.464	0.37	0.23	0.00	1.21	-0.748

Table 8: Regression results for trading volume event study. Two-sided t-test, * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day. Type refers to the type of event: RE = renewable energy, N = nuclear policy, C = climate policy, D = divestiture related.

Event date t	Description	Source	Type	Exp. effect	α_{EON}	β_{EON}	R^2_{EON}	$\hat{s}(v_{\text{EON}})$	$v_{\text{EON},t}$	α_{RWE}	β_{RWE}	R^2_{RWE}	$\hat{s}(v_{\text{RWE}})$	$v_{\text{RWE},t}$
15-Sep-2015	Spiegel leaks information on draft Warth and Klein study conclusions allegedly identifying a EUR 30bn nuclear funding gap.	Dohmen (2015)	N	-	0.29	1.16	0.08	1.13	0.969	0.37	0.25	0.00	1.21	2.811***
17-Sep-2015	After pressure from all four utilities, minister in charge of energy, Gabriel, denies Warth and Klein conclusions. RWE is in talks for capital injection with Abu Dhabi investment firm.	Dohmen and Schießl (2015-09-19)	N	+	0.30	1.22	0.09	1.13	-0.486	0.37	0.37	0.01	1.23	-0.428
5-Oct-2015	Duin, economy minister of utilities' home state North-Rhine Westphalia, demands to cap nuclear liabilities in order not to endanger utilities.	Welt (2015)	N	+	0.30	1.12	0.08	1.13	-0.495	0.32	0.33	0.01	1.13	-0.469
8-Oct-2015	Publication of stress test (Warth and Klein) report with main conclusion that firms set aside enough nuclear decommissioning funds.	Copley and Eckert (2015)	N	+	0.26	0.94	0.06	1.05	-0.415	0.31	0.46	0.01	1.10	-0.923
1-Dec-2015	RWE announces to split off Innogy.	Terium and Günther (2015)	D	+	0.19	0.50	0.02	0.93	-0.207	0.28	-0.25	0.00	1.01	6.995***

Table 8: Regression results for trading volume event study. Two-sided t-test, * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day. Type refers to the type of event: RE = renewable energy, N = nuclear policy, C = climate policy, D = divestiture related.

Event date t	Description	Source	Type	Exp. effect	α_{EON}	β_{EON}	R^2_{EON}	$\hat{s}(v_{\text{EON}})$	$v_{\text{EON},t}$	α_{RWE}	β_{RWE}	R^2_{RWE}	$\hat{s}(v_{\text{RWE}})$	$v_{\text{RWE},t}$
27-Apr-2016	Commission unveils plans for utilities to pay EUR 23.3bn towards the cost of storing nuclear waste in exchange for a cap on storage liabilities. It is expected that the government follows the recommendation.	Financial Times (2016)	N	+/-	0.28	0.20	0.00	0.99	0.773	0.55	2.00	0.06	2.25	0.339
12-Sep-2016	EON's subsidiary Uniper is first listed in a spin-off to existing shareholders.	Steitz and Schütze (2016)	D	+/-	0.30	0.22	0.01	1.31	3.738***	0.63	0.12	0.00	2.58	5.534***
7-Oct-2016	RWE's subsidiary Innogy is first listed in an IPO including an equity increase.	Steitz (2016-10)	D	+/-	0.29	0.22	0.01	1.25	2.959***	0.75	0.36	0.00	2.77	5.214*

Addition to abnormal change in volume	EON			RWE		
	*	**	***	*	**	***
0	6.29%	4.29%	3.43%	6.29%	3.43%	2.29%
2	60.57%	48.29%	30.00%	32.86%	20.86%	11.43%
5	100.00%	96.57%	89.71%	93.71%	87.14%	75.14%

Table 9: Brown Warner simulation for trading volume event study. Percentage of significant regression results of 350 two-sided t-tests for event dates drawn randomly from t = [01-Jan-2013; 07-Oct-2016], * p<0.10, ** p<0.05, *** p<0.01. Normal period is 100 days prior to event day, event period is the event day.

Brown Warner simulation See table 9.